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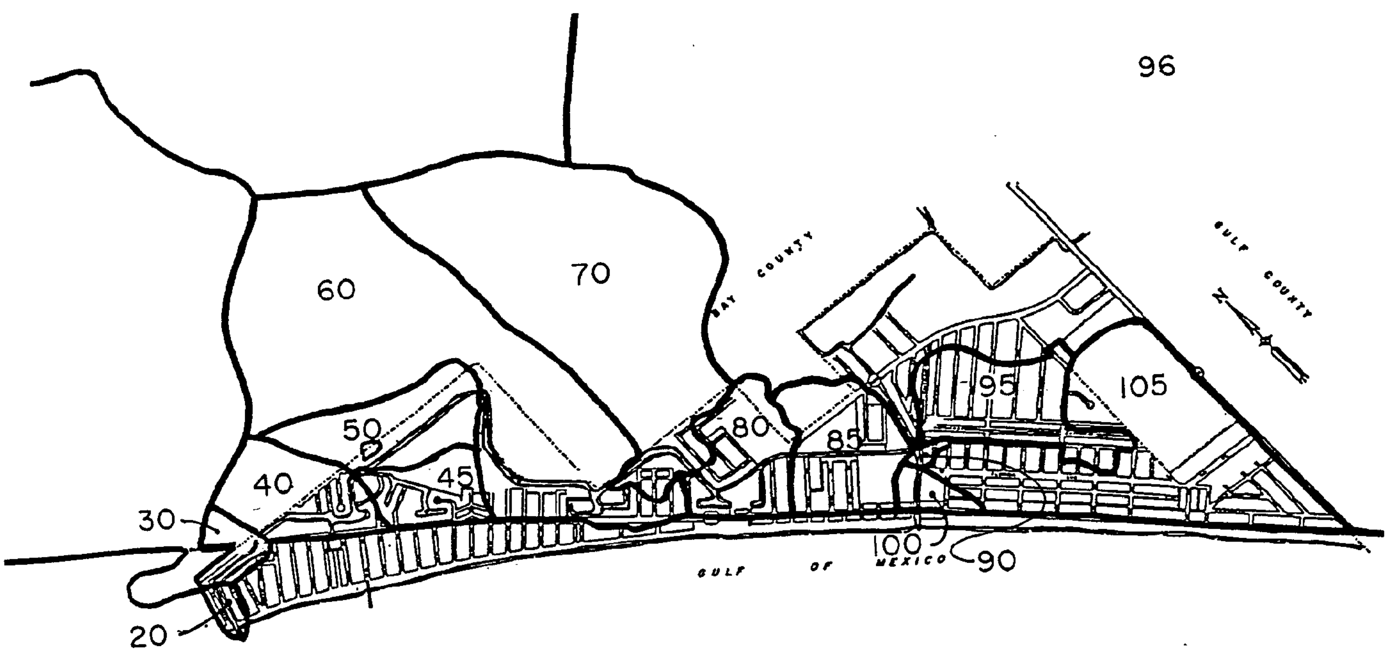
CITY OF MEXICO BEACH
STORMWATER MANAGEMENT PLAN



CITY OF MEXICO BEACH

STORMWATER MANAGEMENT PLAN

Prepared by
BCM Converse Inc.
and
Buchanan and Harper, Inc.
December, 1989

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INTRODUCTION

This Stormwater Management Plan was undertaken to assess the degree of stormwater problems in Mexico Beach and to further provide alternatives for improvements based on this assessment. The assessment included delineation of topographic contours, drainage basins, drainage sub-basins, existing conveyance systems and future land use. These parameters were then evaluated using the Stormwater Management Model (SWMM), Version 4 developed by the U. S. Environmental Protection Agency.

This plan involves two basic components: 1) improvements associated with correcting existing problems with the conveyance system; and, 2) regulation of development to reduce the potential for future problems. Analyses included both water quantity and quality considerations intended to address both flooding and pollution aspects of stormwater management.

1.0 STORMWATER MANAGEMENT PLANNING*

The concept of preventing and reducing the source of stormwater pollution best applies to developing urban areas, for these are areas where development encroachment is yet minimal, or at least controllable, and drainage essentially conforms to natural patterns and levels. Such lands, in consequence, offer the greatest flexibility of approach in preventing pollution. What is required, therefore, is to manage development in such a way that a runoff regime may be retained close to natural levels. It is in these new areas where proper management can prevent long-term problems.

The goal of planning is to develop a macroscopic management concept to prevent the problems resulting from short-sighted development of individual areas. When considering stormwater management, the planner is interested in controlling the volume and rate of runoff as well as the pollutional characteristics. The goal is to preserve the initial ecological balance so that expensive downstream facilities can be minimized. Since the size of storm sewer networks and treatment plants is quite sensitive to the flow, quantity, and particularly the peak flowrate, a reduction in total volume or a smoothing out of the peaks will result in low construction costs.

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*Adapted from: Urban Stormwater Management and Technology, U.S. Environmental Protection Agency, Pub. No. EPA-600/8-77-014.

Having set goals for the watershed, the planning agency has two basic choices for achieving the water quality standards. Either the individual sites can be forced to comply with individual practices and performance standards that fit into the master plan, or the basin system can be designed and maintained as a public utility. The decision on how to blend the options to meet specific site conditions is the key to implementing a basin plan. Isolated development tracts can be controlled by requiring developers to follow specific source control practices, or a simple set of performance standards can be applied and the choice of practices can be left up to the developer. For example, the agency can require that the runoff from the developed site must not exceed predevelopment intensity. The developer will have to minimize runoff producing areas and provide detention facilities at the site.

When dealing with individual or small-scale construction in an urbanizing area, a public utility must ensure that stormwater control planning is implemented. The utility needs the power to acquire land to preserve natural floodways and infiltration areas before development overruns the best sites. Dealing with the small-scale development is a difficult political problem when stressing nonstructural controls. Plans must be developed, and specific sites must be set aside for greenways, detention ponds, and floodways before urbanization begins. This involves buying the land or inverse condemnation before the tax base has been developed to pay for it.

Planners also must consider the effects of their actions on areas outside the individual watershed. For example, detaining storm flow in a downstream watershed while it remains unregulated upstream can cause higher flood levels than a completely unregulated system.

The traditional urbanization process upsets the existing water balance of a site by replacing natural infiltration areas with roadways, parking lots, roofs and other impervious areas. The increased quantity of runoff is carried away in concrete culverts or compacted earth channels instead of in natural channels and grassy floodways. The net impact is increased runoff, decreased infiltration to the groundwater, and increased flowrates. The increased flow velocities will mean increased channel erosion and the transport of surface material to receiving waters. Although most of the surface material is natural and harmless on the land, it will become a water pollutant contributing to stream degradation. If the natural drainage features can be preserved, flowrate increases will be minimized and pollution loads contained.

The key to preserving a natural drainage system for an urbanizing area is understanding the predevelopment water balance and designing to minimize interference with the system. The soils and hydrology of the site must be studied so that high-density, highly impervious construction, such as shopping centers and industrial complexes, is located in areas with naturally low infiltration potential, and the best areas are preserved as open, undisturbed space in parks and woodlands. Runoff from developed areas should be directed to the recharge areas and detained to make the best use of the full infiltration potential. Any necessary drainage channels should be modeled on the natural swales of the undeveloped site. The broad, grassy swales will slow down the runoff and maximize infiltration. The drainage plan can include variable depth detention ponds that will rise during a runoff event and return to a base level during dry weather.

Realizing that the goal of the design is maximizing infiltration-recharge and minimizing runoff, the planner should be able to incorporate the following techniques into the site plan:

- Roof leaders should discharge to pervious areas or seepage pits.

- As much area as possible should be left in a natural undisturbed state. Earthwork and construction traffic compact the soil and decrease infiltration.

- Steep slopes should be avoided. They will contribute to erosion and lessen recharge.

- large expanses of impervious area should be avoided. Parking lots can be built in smaller units and drained to pervious areas.

- No development should be permitted in flood plains.

If natural drainage techniques are developed at a site, the resulting system should provide a water balance closely approximating the predevelopment conditions. The site will be less densely populated than most planned areas; however, the planner will have a community that should be more desirable to live in. In any event, an effective stormwater management program can only be achieved through a balance of regulation and physical improvements. Regulation is intended to avoid problems which might be caused by future development while physical improvements are employed to correct past mistakes.

2.0 PLANNING CONSIDERATIONS

A variety of fundamental factors are instrumental to the preparation of a stormwater management plan. These factors include natural features such as topography, slope, soil conditions and drainageways as well as other conditions such as land use, intensity of urban development, drainage structures and future land use.

2.1 Land Use

The City of Mexico Beach is a small, resort-oriented community located adjacent to the Gulf of Mexico in the southeastern corner of Bay County. The City's 1988 population is estimated at 1,193 persons with a summer seasonal population of approximately 3,000-4,000 persons.

Land use is predominantly low density residential interspersed with some service-oriented and retail commercial uses. Approximately 44% of the land area within the City is currently vacant. Available land within the City could potentially accommodate a population of 6,000-8,000 persons.

During the period 1980-1986 Mexico Beach experienced a tremendous population increase growing from 632 to 1176 persons. This translates into an 86% growth rate for the six-year period or an annual growth rate of 14.4%. In this regard, Mexico Beach was the fastest growing municipality in Bay County during the 1980-1986 period. During this time regulations for septic tank installations have changed which will tend to reduce further medium-density (townhouse) development.

In general, the development potential of Mexico Beach is constrained by lack of a central sewage system and predominate soil types which present moderate to severe limitations on septic tank use. Unless funding for design and construction of a central sewer system is obtained the City will continue to develop as a predominately low-density residential community.

As shown on the existing land use map the City is primarily residential in character predominated by low-density residential land use interspersed with some medium and high density uses. Scattered commercial uses are also located along the City's major roadway US 98. Land uses within the City are described as follows.

Residential:

Residential land use in Mexico Beach is comprised of low-density single-family detached and duplex residences, medium density mobile home parks, and higher density townhouse and apartment-units.

During the early 1980's multi-family townhouse and apartment uses were increasing; however, since that time changes in septic tank regulations have decreased this trend.

Residential development in the City is following the classic pattern experienced in most seasonal resort communities. As land costs near the waterfront increase, more units per acre are constructed to produce a higher sales return. As property values decrease for inland or non-waterfront locations, per unit densities also decrease accordingly.

Current densities average 5 dwelling units per acre for low density residential uses and 8-17 units per acre for medium to high density uses. Figure 1 shows these uses in relation to waterfront and non-waterfront locations.

Commercial:

Commercial activities in the City consist primarily of resort/motel/restaurant and retail sales/service land uses. The majority of these front upon the U.S. 98 corridor and are oriented towards seasonal business activity. In general, fulltime residents travel to other nearby cities for major shopping.

Industrial:

There are two industrial land uses in or near the Mexico Beach City limits. Wallace Pump and Supply Company is a light industrial facility located on SR 386-A. The other industrial facility, Harmon's Heavy Equipment Company, is located outside the City limits on SR 386.

Recreation:

Water-oriented activities associated with the Gulf of Mexico and the beach are the primary sources of recreation in Mexico Beach. Swimming, sunbathing and fishing are the main activities for both residents and visitors. Recreational facilities include a municipal fishing pier, three gulf-front parking lots for beach assess, boat launches, two tennis courts, and the Mexico Beach Canal Park. There are also two large R/V campgrounds which provide private recreational facilities.

Public/Institutional:

Public buildings and grounds and other public facilities have been combined within this land use category. Public areas within the City are the water treatment plant and City Hall. City Hall houses the Fire Department, the Police Department, the public meeting hall and the City's administrative offices. Institutional land uses are churches and other non-profit organizations.

Conservation:

Conservation uses include the area south of U.S. 98 from 8th Street eastward to the Gulf County line, excluding the Parker Tract, and the beach area seaward of the coastal construction control line. These areas are under local or state jurisdiction for the purpose of reducing storm-related damage, protecting natural resources and providing beach access. The privately-held Parker Tract is on the Save-Our-Coast list for possible state purchase.

Vacant:

Vacant lots and some large parcels are interspersed throughout the City. In general, the majority of vacant land is located north of U.S. 98, toward the northern boundary of the City limits. These areas are generally low and swampy requiring fill for development. There is also a possibility that jurisdictional wetlands are located in these areas which would necessitate state/federal permit for development.

Adjacent Land Uses:

The majority of the land surrounding Mexico Beach is undeveloped. To the north are some individually-held vacant parcels, however, most of the land is owned by the St. Joe Paper Company.

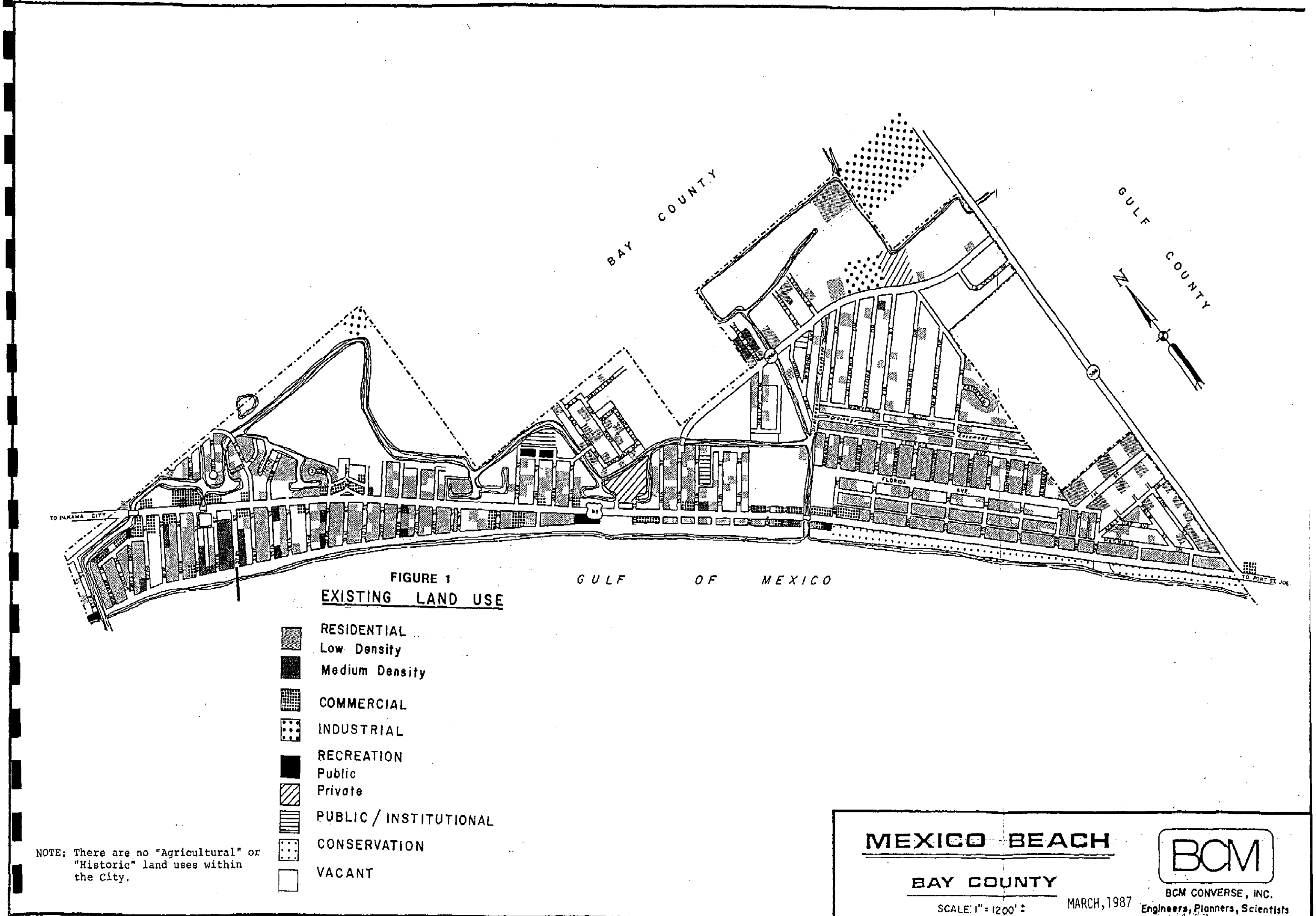


FIGURE 1
EXISTING LAND USE

To the west is a privately-held parcel called St. Michael's Landing. At this time, it is uncertain whether this parcel will be developed or be acquired by the State for a public park.

The eastern limit of Mexico Beach is also the jurisdictional boundary between Bay and Gulf Counties. Land uses in Gulf County adjacent to Mexico Beach are low to medium density residential interspersed with limited commercial uses.

2.2 Urban Development

As mentioned previously, the City of Mexico Beach could hardly be considered an intensely urbanized area. Developed areas, including public facilities, account for approximately 55% of the total area of the City. The approximate intensity of urban development by land use has been estimated as follows.

Land Use	(% of Total Area) Intensity
Residential	20%
(Low Density, 1-5 DU/Acre)	(14)
(Medium Density, 6-20 DU/Acre)	(6)
Commercial	1%
Industrial	0.5%
Public/Institutional	0.4%
Other	32%
(Roads, Canal, Beach)	

Source: BCM Converse Inc.

The preceding estimates indicate that residential areas and other facilities, such as roads, comprise the majority of urban development within the City. These types of development can reasonably be expected to produce 40% - 60% impervious or paved surface (lot coverage) which could potentially increase runoff and pollutant loads.

The 40% to 60% lot coverage is considered relatively low-intensity development. Unpaved portions (60% to 40%) of each lot provide some available area for runoff retention and soil percolation. Under these circumstances, the intensity of development within the

City is not the major contributor of increased runoff as much as other factors such as poor site conditions.

2.3 Physical Features

Physical features are naturally occurring site conditions which influence development potential and drainage patterns. These features include physiography and topography, geology, groundwater hydrology, and soil conditions. Each of these is described as follows.

2.3.1 Physiography and Topography

Mexico Beach is located in the coastal dunes portion of the East Gulf Coast section of the Coastal Plains physiographic province (Hunt, 1967). The beach dune deposits paralleling the coast are the result of coastal currents and on-shore wind that has deposited sand into 10 to 25 foot dunes paralleling the coast that have relief on the order of 10 to 25 feet. Immediately inland are found extensive wooded marshes interspersed with some drier areas. Scattered small lakes and dry drainage ditches assist in creating drier land. As expected, the slopes are extremely low except on the dune face.

Topographic contours range from approximately 20 foot elevations principally along US 98 to sea level. Average elevations throughout the City are in the 12-14 foot range. In general, the topography is basically flat except for areas immediately adjacent to the shoreline. Topographic contours are discussed further in subsequent sections of this report.

2.3.2 Geology

The underlying geology of the Study Area is comprised of coastal plain sediments of marine and estuarine origin. From oldest to youngest, these formations can be generalized into three groupings: limestone and dolomite, marls and clayey sands, and marine and alluvial sands and terraces. The surface deposits are sand and muck with dunes paralleling the coast and swampy terrain found one-quarter to three-quarter mile inland.

The eight formations of the Eocene Series and Oligocene Series are limestone and dolomite beds, distinguished primarily on the basis of fossil evidence. These formations, together with the lower stage of the Miocene Series, constitute the Floridan Aquifer. These are discussed more fully in the section "Groundwater and Hydrology".

The middle and upper stages of the Miocene Series include formations composed of marl and silty and clayey sands, forming an impervious cap to the lower limestone aquifer. The Citronelle Formation of Plio-Pleistocene Series, the Pleistocene Series and recent and Pleistocene deposits include alluvial sands, gravels and clays, marine terraces, and recent marine sediments. The dunes are built up by the interaction of waves and on-shore winds. They stand up to 10 to 20 feet above the inland areas which consist of muck-filled swamp and slightly higher ground which remains fairly dry due to the high permeability of the sandy soils prevalent in such areas.

2.3.3 Groundwater Hydrology

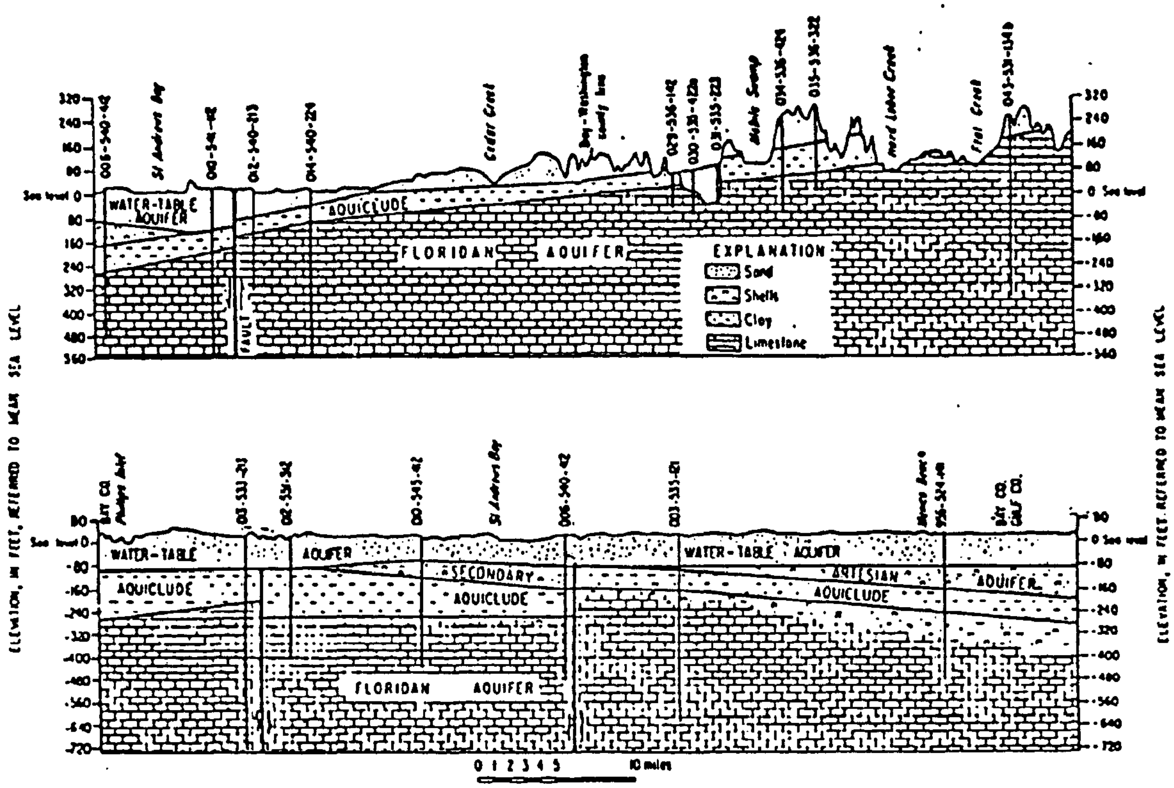
Due to the stratigraphic and water bearing characteristics of the geologic formations underlying the City, three distinct aquifers are formed. Very porous, permeable surface sands, ranging from 65 to 140 feet thick along the coast, and 10 to 30 feet further inland, form the unconfined, water table aquifer.

Underlying this is an impermeable layer of sandy clay and clayey shell material which forms an aquaclude, blocking the vertical movement of water. An artesian or confined aquifer is formed below this aquaclude, known as the Floridan Aquifer. This aquifer is composed of limestone formations that are as much as 1,200 feet thick (Musgrove et al., 1965).

Between the base of the water table aquifer and the top of the Floridan Aquifer is a bed of shell-hash interlayered with sand and limestone lenses. A cap of sandy clay material acts as a semi-confining layer which maintains water in this shell-hash under pressure, forming a secondary artesian aquifer. Figure 2

FIGURE 2

Geohydrologic Sections of Econfina Creek Basin Area



SOURCE: Bay County 201 Facilities Plan

illustrates a cross-sectional view of the arrangement of these three aquifers.

Groundwater of the shallow unconfined aquifer originates from rainfall percolating directly down from the land surface. As this water moves through the aquifer and is blocked by the impermeable sand and clay aquaclude at the base, it seeps out into surface streams and maintains base flow during periods of no rainfall. Since the boundary between the water table aquifer and the secondary artesian aquifer is only semi-confining, some water may seep downward to provide a source of groundwater in this lower aquifer.

Water in the Floridan Aquifer underlying the study area enters the aquifer to the north of the study area through sink holes and areas where the limestone formations are at the ground surface (Musgrove _et_ _al_., 1965).

2.3.4 Soil Conditions

Soils found in Mexico Beach can be generally grouped into three basic categories: 1) coarse sandy soils found along dunes and beaches; 2) fill and disturbed soils associated with urban development; and, 3) nearly level, poorly drained soils normally associated with low-lying areas. Soil conditions relative to drainage and stormwater management for soils in Mexico Beach are described as follows and shown on Figure 3.

Soil Type	Limitations on		Conditions	Depth to	
	Texture	Drainage	Slope	Water Table	Permeability
Leon (13)	Sand-fine sand	Cutbacks cave	0-2%	0-1'	Poorly drained
Mandarin (27)	Sand-fine sand	Cutbacks cave	0-2%	1.5'-3.5'	Poorly drained
Rutlege (29)	Sand-loamy sand	Ponding, cutbacks cave	0-2%	+2'-1'	Very poorly drained
Pottsburg (30)	Sand-fine sand	Cutbacks cave	0-2%	0-1'	Poorly drained
Arents (40)	Sand	Deep to water	0-5%	76'	Variable
Beaches (44)	Sand	Deep to water	Variable	-	Variable
Fripp (48)	Sand-fine sand	Deep to water	2-30%	76'	Moderately well drained
Palmico (51)	Muck-loamy sand	Flooding cutbacks cave	NA	0-1'	Very poorly drained

Source: Soil Survey of Bay County Florida, Soil Conservation Service, 1984.

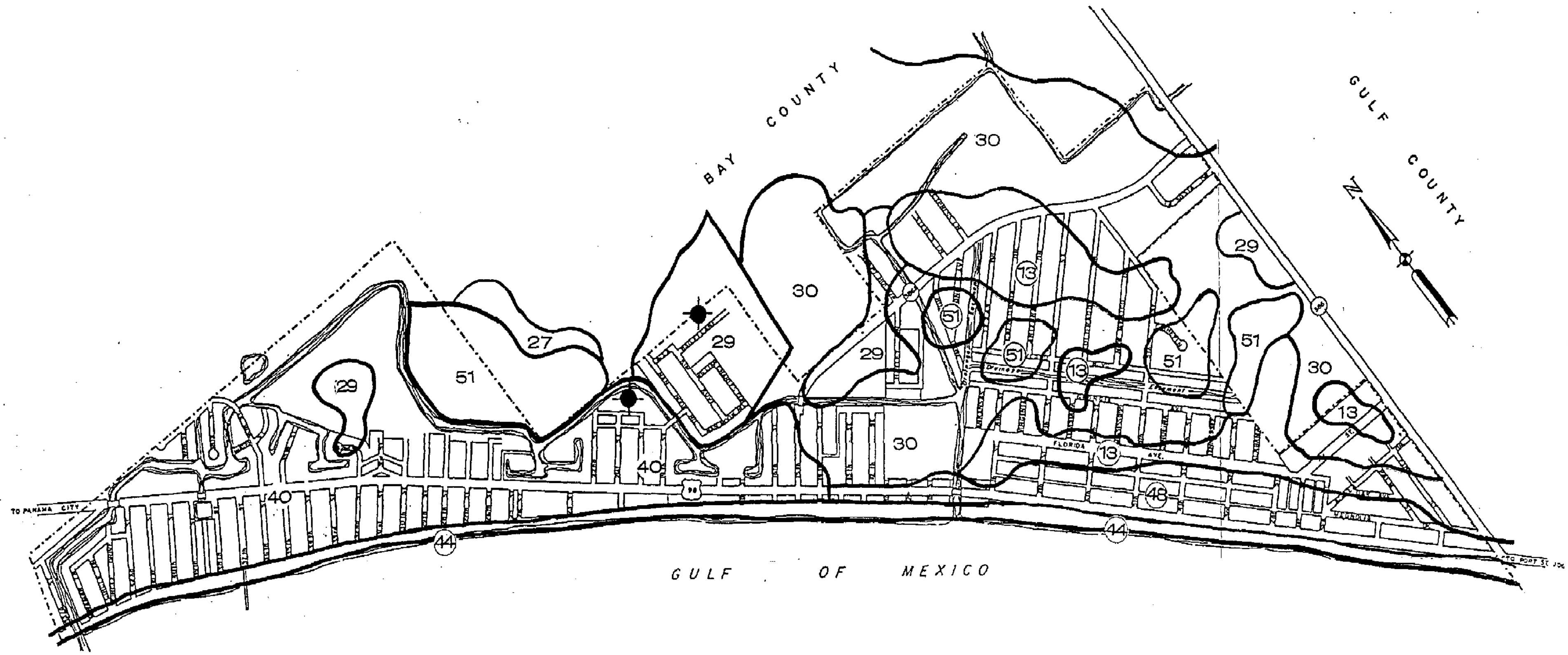


FIGURE 3
SOIL TYPES

MEXICO BEACH

BAY COUNTY

SCALE: 1" = 1200'

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Based on the preceding conditions and distribution of soils shown on Figure 3, approximately 50% of areas within the City present potential drainage problems. All soils listed above are described as presenting slight potential for erosion.

It should be noted that the majority of poorly-drained, low-lying soils are generally found in the predominately vacant areas of the City (see Figure 1). As these areas are developed and/or filled drainage patterns and volumes of runoff could be altered.

2.4 Future Land Use

Two predominate factors will influence the type, distribution, and extent of future land use in Mexico Beach. These are : 1) number of residential units and size of commercial buildings allowed by State septic tank regulations (Chapter 10D-6, FAC); and, 2) the extent of subdivided, platted lots currently in existence.

2.4.1 Septic Tanks

The City does not own, operate or otherwise participate in a central sewage system. All development within the City uses septic tanks for sewage treatment. Figure 4 shows soil types within the City and their suitability for septic tank use. As shown, a considerable portion of the City contains soils which present severe limitations on use of septic tanks. In these areas installation of septic tanks requires fill or other site

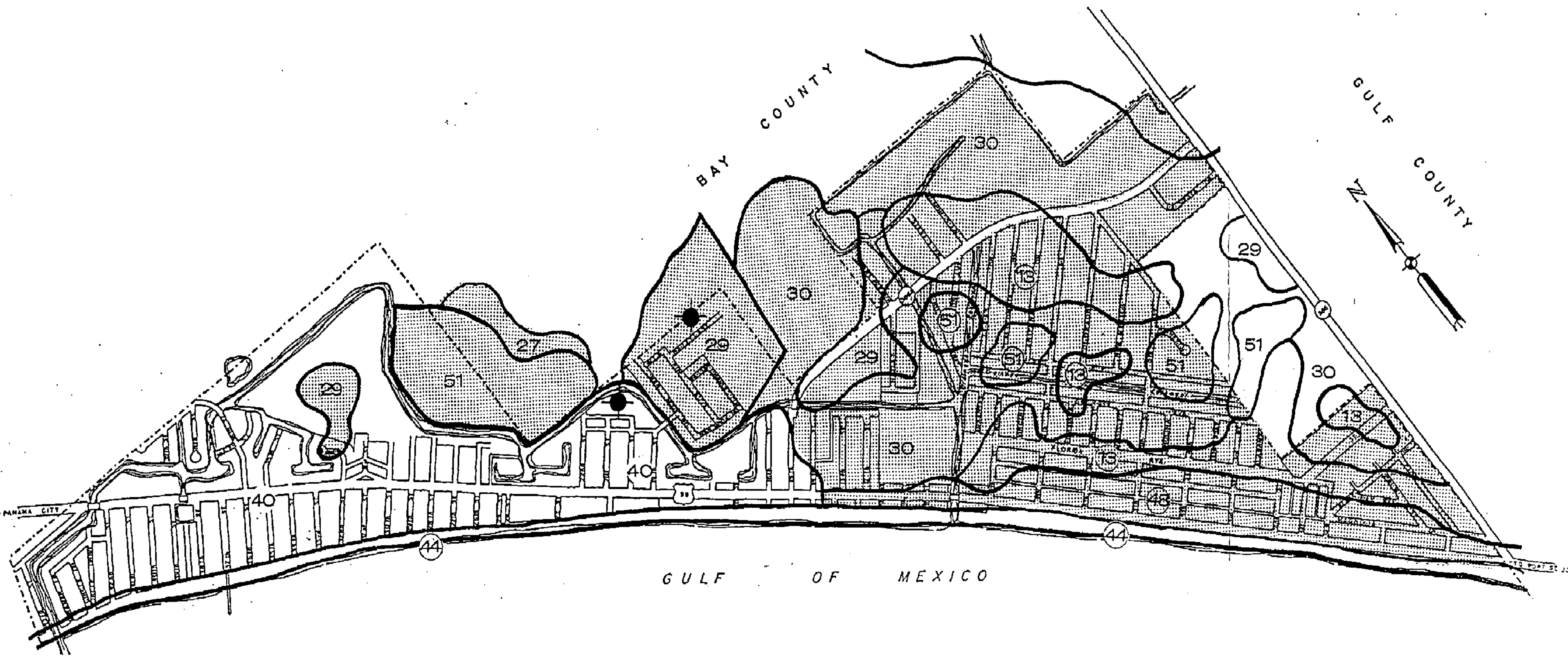

FIGURE 4
SEPTIC TANK SUITABILITY

SEVERE LIMITATIONS ON USE

MEXICO BEACH

BAY COUNTY

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modification in order to meet percolation requirements. Lack of a central sewer system and soil conditions for septic tank use present a major problem for future growth. Also, continued use of septic tanks could result in groundwater contamination, pollution of the canal system or other health hazards. Recognizing this problem, the City has continually emphasized the construction of a sewage system as a priority item.

The Department of Health and Rehabilitative Services (HRS) is authorized to regulate individual sewage disposal facilities pursuant to Section 381,272 F.S. and the attendant Florida Administrative Code rules and standards. Part VIII (Onsite Sewage Disposal) of the Water Quality Assurance Act of 1983 created more stringent regulations for septic tank installation. In subdivisions with 0.25 acre lots and a public water system, septic tanks can be used if the average daily sewage flow does not exceed 2,500 gallons per acre per day. This part also established a septic tank setback of 75 feet from surface waters. For lots platted prior to 1972, it established a 50 foot minimum surface water setback and an exemption from size requirements provided that sewage flows do not exceed 2,500 gallons per acre day for lots with public water systems.

Based on current septic tank regulations it is very probable that residential densities will not exceed 6 units per acre for existing subdivisions and 4 units per acre in unplatted areas.

2.4.2 Platted Lots

An important future land use consideration is the extent and size of platted areas. A considerable portion of the City has been platted into residential or commercial lots. Although lot dimensions differ from area to area the most common lot size is approximately 7500 square feet, with the majority of lots being platted prior to 1972. In most cases, deed restrictions recorded for platted areas limit use of lots to residential or commercial lodging purposes.

Figure 5 shows platted areas within the City. Also shown and numbered are larger, unplatted vacant areas capable of supporting future development, except for vacant area 1 which is platted.

With the exception of vacant area 1, all other vacant areas exhibit soil characteristics which pose limitations on building site development and use of septic tanks. These conditions can, and have, been overcome through use of fill and associated site modifications.

2.5 **Comprehensive Plan**

The City is currently in the process of revising its comprehensive plan pursuant to Chapter 163, F.S. and Chapter 9J-5, FAC. The plan was submitted to the Department of Community Affairs on December 1, 1989 and, as such, has not been officially adopted.

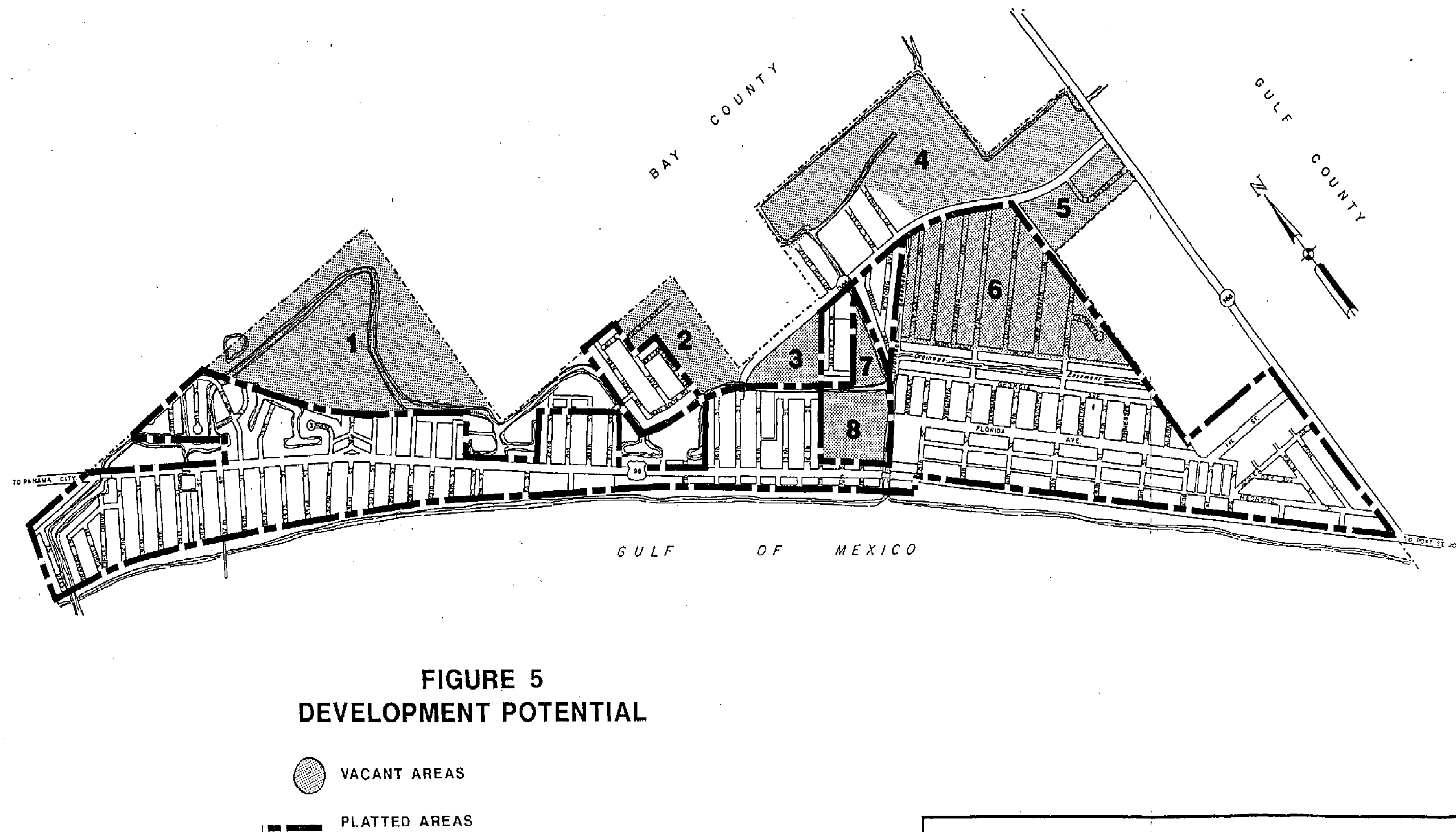

FIGURE 5
DEVELOPMENT POTENTIAL

MEXICO BEACH

BAY COUNTY

SCALE: 1" = 1200'

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The draft comprehensive plan does provide proposed land use districts, dwelling unit densities, and land use intensities which provide useful guidelines in determining future development potential.

2.6 Development Potential

General estimates of development potential were prepared for the vacant areas shown on Figure 5. Factors considered include amount of vacant acreage, densities proposed on the Comprehensive Plan-Future Land Use Map, and the amount of impervious surface (roof, driveways, road, etc.) generated by potential development. These estimates are as follows.

Vacant	Est. Gross	Development Potential*		Est. Acres of Impervious Area**	
Area	Acreage	4 du/acre	6 du/acre	4 du/acre	6du/acre
1	83	264	396	33	35.7
2	21	64	96	8.5	9
3	10	30	45	4	4.3
4	62	184	276	25	26.6
5	9	28	42	3.6	3.9
6	46	140	210	18.4	19.8
7	7	20	30	2.8	3
8	17	52	78	6.8	7.3

*Number of residential dwelling units

**Roofs, driveways, roads, etc.

Source: BCM Converse Inc.

Only vacant area 1 has been platted including dedicated streets and ROW. Subdivision of the remaining vacant areas would be subject to the City's subdivision regulations, DER stormwater regulations, and septic tank regulations limiting density to four lots per acre.

In general, it is anticipated that the City will continue to develop as a low-density, residential community. Residential development will be limited to single-family, duplex, and mobile home dwellings with lot coverage limited to 40%. Small-scale commercial activity and development will continue to occur along US 98. These commercial activities will be allowed 90% lot coverage and will be the principle generators of parking lots and other major areas of impervious surface.

3.0 STORMWATER BASIN

The contributory area for stormwater is best described as a single large basin (approximately 17 square miles) with many sub-basins. The basin outfalls to a canal system which circumnavigates the City. The canal system begins at the Gulf of Mexico and ends at the Gulf of Mexico.

The basin is comprised of the city limits of the City of Mexico Beach and adjacent silviculture areas located to the north. The silviculture areas discharge to the canal system through both sheet flow and two creek systems. The westernmost creek system is known as Salt Creek with a contributory area of approximately 1.6 square miles. The easternmost creek system is known as Cypress Creek with a contributory area of approximately 14 square miles. The remainder of the silviculture area, approximately 1.4 square miles, sheet flows to the canal system.

The silviculture areas are comprised of forested timberland, forested wetland, and hardwood swamps.

The City of Mexico Beach is comprised of undeveloped timberland and wetland along with residential areas. Developed impervious areas are predominantly isolated to the westernmost part of the city along U.S. 98.

3.1 STREET TYPES AND CONDITIONS

The streets within the study area are comprised of both paved and unpaved surfaces with roadside ditches. The roadside ditches act as the main conveyance system in the more developed portion of the City for transmittal of stormwater to the major outfall systems.

4.0 STORMWATER FACILITIES

4.1 TRUNKLINE OUTFALL SYSTEM

The primary trunkline outfall system consists of a manmade excavated canal system, approximately 3 miles in length, which is comprised of one main canal with offshoots. The main canal begins in the westernmost portion of the city at an outfall to the Gulf of Mexico, thence north to the city limits, thence east-northeast roughly following the city limits boundary, thence turning south to discharge into the Gulf of Mexico approximately 9800 feet east of the westernmost outfall. Beginning at the westernmost outfall, the canal system is well maintained and of sufficient size for maritime traffic for approximately one fourth its length. From there the system is predominantly a large ditch system connecting isolated larger sections. Refer to Figure 6 for a layout of the system.

Discharging into the main trunkline system are several minor trunkline systems located in the eastern portion of the City.

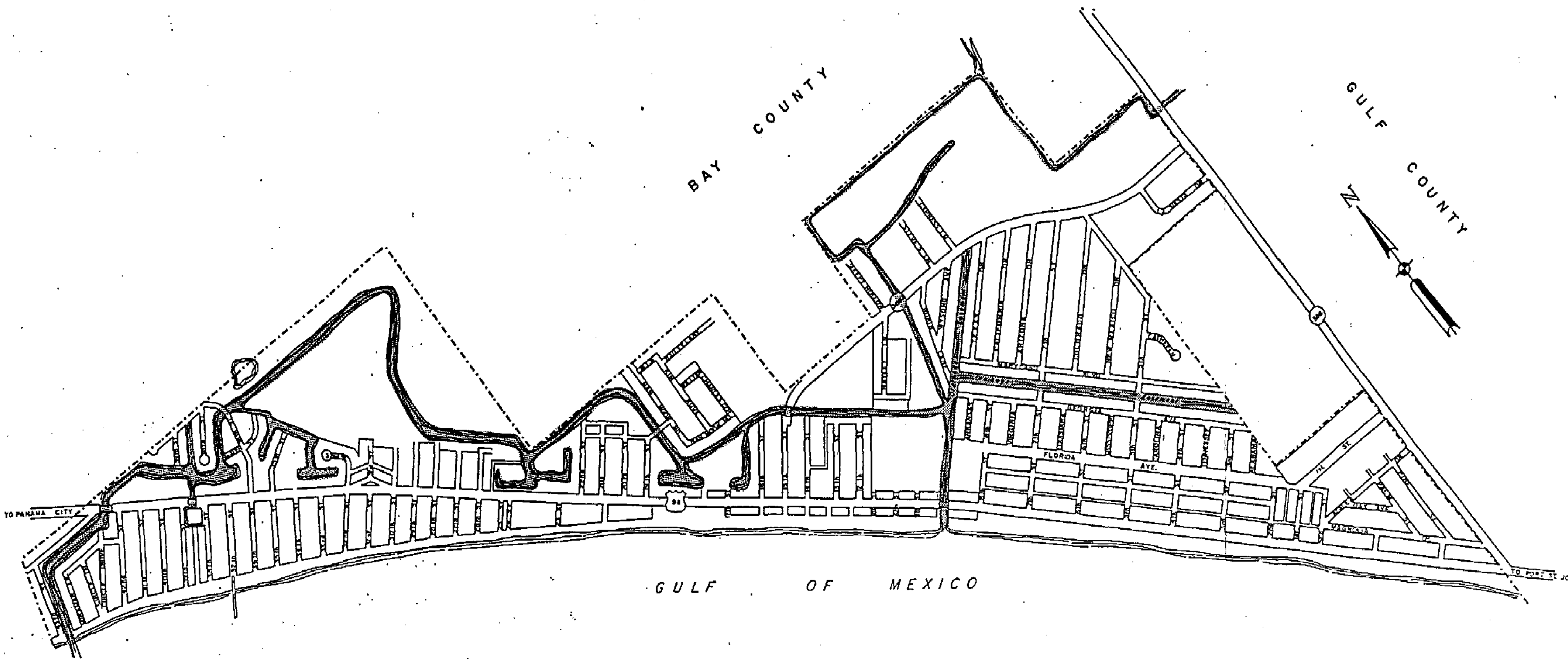

FIGURE 6
TRUNKLINE OUTFALL SYSTEM

MEXICO BEACH

BAY COUNTY

SCALE: 1" = 1200'±

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The largest of these minor trunkline systems is the system which conveys Cypress Creek. The remainder of the minor trunkline systems consist of collector ditches for roadside ditches within the more developed residential portions of the City.

4.2 FLOODING PROBLEMS

Based on conversations with the City of Mexico Beach personnel, the greatest flooding problems are isolated in two locations. The first location is the ditch system contained between Maryland Blvd. and S.R. 386A. The second location is an area north of the canal system and just west of where S.R. 386A crosses the canal system. Refer to Figure 6 for locations.

5.0 STORMWATER ANALYSIS AND MODEL DEVELOPMENT

5.1 MODEL DEVELOPMENT

The model selected for use in analyzing the drainage system is the Stormwater Management Model (SWMM), Version 4, developed by the U.S. Environmental Protection Agency and updated by the University of Florida. Version 4 of the model is the latest release currently available. This model has been widely applied to urban stormwater management studies throughout the country with good success and is thought to be the most comprehensive model currently available for analysis of urban systems.

Link/Node System

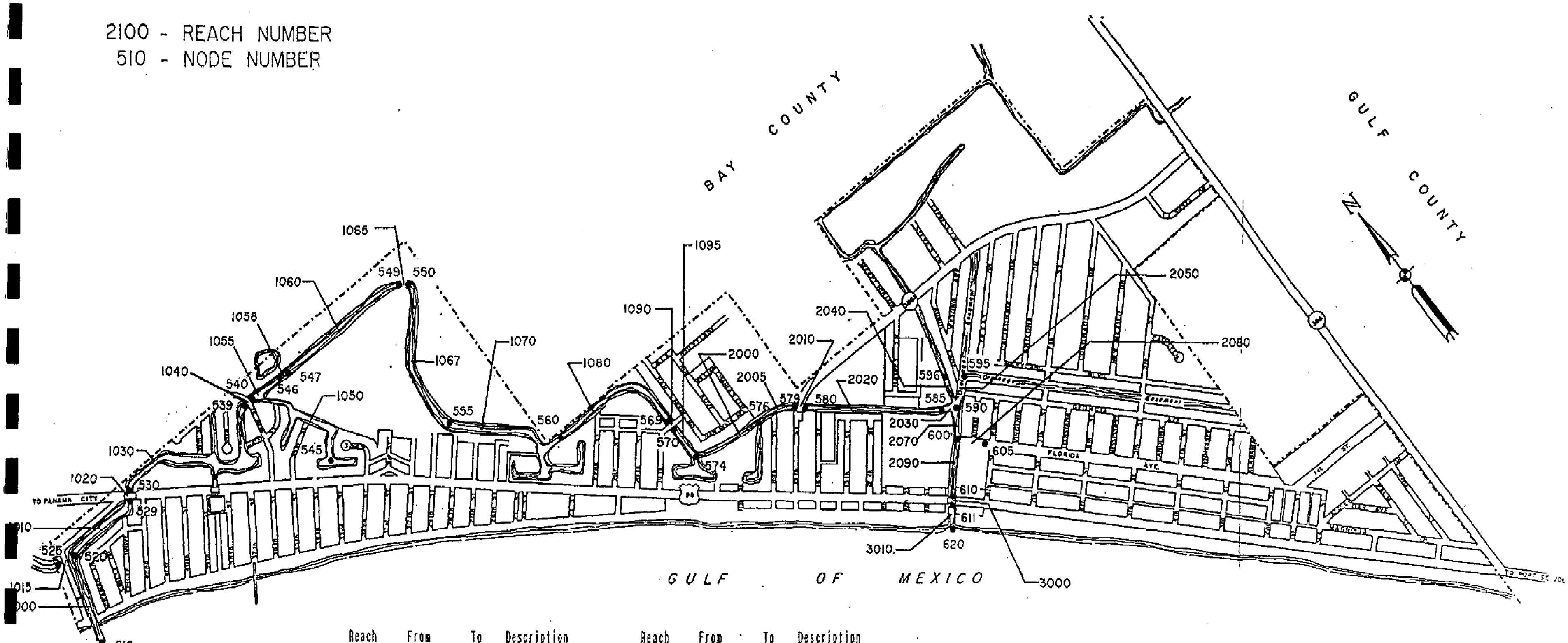
In order to begin the modeling process the existing drainage system had to be equated to a link/node system as a method of describing flow connection points and flow transmittal points. Refer to Figure 7 for the layout of the link/node system and the labeling system. Determination of the locations of nodes is based on points of interest in the system, transition in conveyance structure, intersection of conveyances, etc.

Development of Sub-basins

Once the link/node system has been developed the basin can be divided into sub-basins tributary to the nodes. The sub-basin areas and characteristics were developed from the aerial maps and U.S.G.S. Quad sheets. Refer to Figure 8 for the delineation of the sub-basins and the labeling system.

Model Parameters

Key input parameters required by the model include total area, impervious area, generalized slope of the sub-basin, hydraulic length of the sub-basin, width of the sub-basin, runoff characteristics, and hydraulic parameters for the conveyance system. For a detailed description of the various parameters refer to the SWMM User's Manual.



Reach Number	From Node	To Node	Description	Reach Number	From Node	To Node	Description
1000	520	510	Natural Channel	1090	570	569	60" CMP Culvert
1010	529	520	Natural Channel	1095	574	570	Natural Channel
1015	525	520	48" RCP Culvert	2000	576	574	Natural Channel
1020	530	529	U.S. 98 Bridge	2005	579	576	Natural Channel
1030	539	530	Natural Channel	2010	580	579	C.R. 386A Bridge
1040	540	539	36th Street Bridge	2020	585	580	Natural Channel
1050	545	540	Natural Channel	2030	590	585	Natural Channel
1055	546	540	Natural Channel	2040	596	585	Natural Channel
1058	547	546	Natural Channel	2050	595	590	Natural Channel
1060	549	547	Natural Channel	2070	590	600	Natural Channel
1065	550	549	24" RCP Culvert	2080	605	600	Natural Channel
1067	555	550	Natural Channel	2090	600	610	Natural Channel
1070	560	555	Natural Channel	3000	610	611	U.S. 98 Bridge
1080	569	560	Natural Channel	3010	611	620	Natural Channel

FIGURE 7
LINK/NODE SYSTEM

MEXICO BEACH

BAY COUNTY

SCALE: 1" = 1200' ±

BCM

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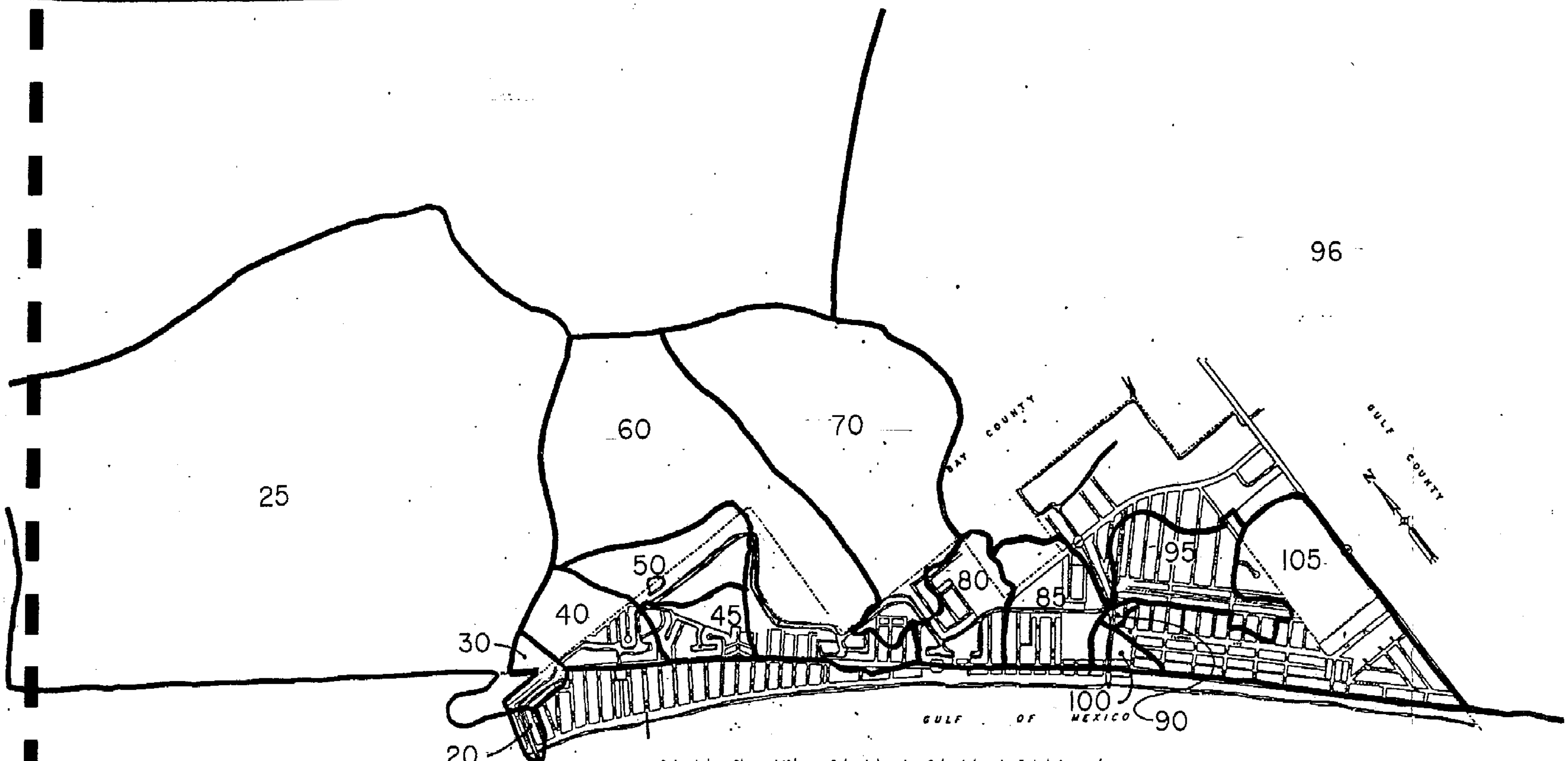
Engineers, Planners, Scientists



Subcatch-ment No.	Channel/Pipe or Inlet Number for Drainage	Subcatchment Area Inside City Limits (Acres)	Subcatchment Area Outside City Limits (Acres)	Total Area of Subcatchment (Acres)
10	510	0	0	0
20	520	10	0	10
25	525	0	1,050	1,050
30	530	7	12	19
40	540	30	35	65
45	545	37	0	37
50	550	34	35	69
60	560	57	299	356
70	570	20	293	313
80	580	63	0	63
85	585	68	0	68
90	590	3	0	3
95	595	92	0	92
96	596	133	8,423	8,556
100	600	14	0	14
105	605	226	0	226
110	610	0	0	0

FIGURE 8
SUB-BASINS

MEXICO BEACH

BAY COUNTY

SCALE: 1" = 2000'

BCM
BCM CONVERSE, INC.
Engineers, Planners, Scientists

Area Characteristics

The total area characteristics were determined by planimetering the sub-basins and by referring to the Florida Department of Transportation basin delineations developed as part of the design of U.S. 98 and S.R. 386A. Directly connected impervious area characteristics were determined based on the land use. For existing land use the directly connected impervious area was estimated based on an evaluation of the aerial photographs. For future land use the directly connected impervious area was estimated based on an assumed percentage for each type of future land use. Percentages for each type of future land use were estimated based on development patterns described in Section 2 of this document.

Hydraulic Length/Slope/Width

The hydraulic length is defined as the distance of overland flow from the furthermost upstream point in the sub-basin to the point of collection. Determination of the hydraulic lengths were made based on the aerial photographs. The slope of the sub-basin was determined by dividing the difference in elevation along the hydraulic length by the hydraulic length. The width is a parameter which approximates the shape of the basin. The width is best estimated by dividing the sub-basin area by its hydraulic length.

Hydrologic/Hydrogeologic Characteristics

Hydrologic/hydrogeologic parameters needed for the model primarily consist of precipitation, infiltration, and depression storage data. Precipitation data used in the model was taken from the synthetic mass rainfall curves prepared by the Swannee River Water Management District based on statistical rainfall data. Based on analyses performed by the Florida Department of Transportation, these rainfall curves are valid for events in northwest Florida. Infiltration information was obtained from the Bay County Soil Survey. Depression storage data was taken from the aerial photographs.

Hydraulic Characteristics

Hydraulic characteristics for the conveyance system include the type of conveyance, physical dimension, slope, and friction or roughness parameters. The type of conveyance, physical dimensions and slope were obtained from field data and the aerial photographs. Roughness parameters were obtained from standardized engineering references.

The remaining characteristics were determined from the topographic maps.

5.2 MODEL ACCURACY

Verification and calibration are generally a necessary integral part of any stormwater management system model development. Calibration is the adjustment of model parameters using one set of known data and verification is the testing of the adjusted model by using an independent set of known data. The necessity of calibration and verification occurs due to the inaccuracy of parameter interpretation. Additionally, analysis of water quality data is based upon limited data and empirical evaluations. Quantity predictions can be approximated without calibration and verification, however, quality predictions may be off by orders of magnitude. Quality predictions are not credible without site-specific data for calibration and verification and may be used only to judge relative effects of pollution abatement alternatives.

Verification and calibration will not be possible for this model due to budgetary constraints. As a result the data obtained from the analysis should be considered an approximation of actual conditions. Without verification and calibration, analysis of water quality via the model would serve no purpose. Therefore, the water quality portion of the model has not been "turned on" and the SWMM model will be used to evaluate quantity only. Quantity predictions, while not being totally accurate, should be of sufficient accuracy to evaluate the existing and future conditions and recommend improvements to the system. Water quality may be evaluated by a rational analysis of the basin without knowing site-specific data and, as a result, best management practices can be recommended which will reduce degradation of the waters.

The natural extension of this project will be to continue it with a second phase whereby, the necessary site-specific data is obtained. The water quality portion of the model is "turned on" and verification and calibration is performed.

6.0 ANALYSIS OF EXISTING CONVEYANCE SYSTEM

This section will consist of a description of the methodology used in analyzing the existing conveyance system. The analysis primarily consisted of selection of an appropriate design storm, simulation of existing and future conditions, and a summary of resultant predictions.

6.1 DESIGN STORM EVENT

The selection of the design storm event is a two part process, selection of an appropriate event return frequency and an appropriate event duration.

Selection of an event return frequency or recurrence interval for a municipality is dependent upon public safety, convenience and economics. Since the system is comprised primarily of open channels the economics of capital improvements is less significant than in a system comprised of rigid structures. Therefore, a larger event return frequency of 25 years was chosen.

The event duration is a more basin specific parameter than the event return frequency. The resultant analysis data from a specific duration storm event will vary with the duration of the storm event in a bell-shaped curve. The duration storms contained at the top of the bell-shaped curve will produce the largest stages and flows within the system. Determination of this critical duration is a trial and error procedure. An initial duration was selected and the analysis generated. Additional durations were then analyzed for the existing system until a critical duration was determined.

6.2 SUMMARY OF RESULTANT PREDICTIONS

The existing conveyance system was modeled for existing land use conditions. The results of the analysis indicated that the existing system exhibited problems from 36th Street east to the Gulf outfall. Flooding was encountered in this area and in some locations exceeded 2.5 feet. The majority of the flooding is the result of an obstruction and an undersized culvert. Improvement alternatives need to be considered in order to reduce the flooding and increase the overall efficiency of the conveyance system.

7.0 IMPROVEMENT ALTERNATIVES FOR EXISTING SYSTEM

This section contains descriptions, costs and recommendations for various improvements to the existing conveyance system. These improvement alternatives are based upon the concept that the conveyance system should function in an efficient manner and all flooding which, in the opinion of the modeler, would result in the endangerment of life or property should be eliminated within the basin. Also, when economically feasible all flooding of uplands shall be eliminated. No effort will be made to reduce flooding in lowland areas.

7.1 GENERAL

Based upon a visual observation of the conveyance system it is apparent that a maintenance program should be implemented. The existing canal system contains locations where erosion has occurred resulting in an obstruction or partial blockage of flow.

Also, locations exist where vegetation or debris has collected resulting in a blockage or reduction in conveyance capacity.

A maintenance program should be implemented with priorities established for the following items:

1. Cleaning of structures - One of the first items which should be addressed is that all culverts should be examined and cleaned to remove all debris, blockage, silt, etc.

2. Removal of Obstructions - The entire system should be inspected for obstructions or partial blockages to flow resulting from erosion, debris, etc. The obstructions should be removed and if required the area stabilized with vegetation or other structural means. Vegetative means of stabilization should be utilized whenever possible due to their inherent water quality benefits. In the event the section shape prohibits the use of vegetation, reshaping of the section should be considered in order that vegetation may be utilized.

3. Easements - Rights of ways and easements should be reviewed for all parts of the system to insure that adequate areas exist for the conveyance and for maintenance. Easements or rights of way should be obtained for all areas with inadequate or non-existent easements.

4. Cleaning of the system - The entire system should be cleaned to remove debris and excessive vegetation and, if necessary, to re-contour and stabilize areas subject to erosion. A regular schedule of maintenance should be established and strictly

adhered to. Initially, cleaning of the system will be labor intensive. However, once the system has been cleaned, future cleaning should be straightforward. The benefits of a regular cleaning schedule will be realized in a reduction in specific problems which must be addressed. Also, routine maintenance will be preventative and cost effective compared to remedial maintenance for the correction of specific problems. The frequency of cleaning operations are somewhat dependent upon the system and will be determined based upon need. However, generally speaking most system require cleaning one to two times per year.

7.2 IMPROVEMENT ALTERNATIVES

Specific improvement alternatives to the existing system were evaluated by making changes to the computer model and executing an analysis of the effects of the changes on the performance characteristics of the conveyance system. Locations for potential improvements were based upon inefficiencies noted in the computer analysis of the existing system. Inefficiencies in the conveyance system can be seen by analyzing the change in elevation or slope of the hydraulic grade line of the conveyance system. Abrupt changes in elevation or steep slopes in the hydraulic grade line indicate areas which are functioning inefficiently. The effect of each alternative or combinations of alternatives upon the hydraulic grade line may be seen by referring to Figures 9 and 10 . The desired effect for any

FIGURE 9

MAXIMUM HYDRAULIC GRADE LINE FOR VARIOUS IMPROVEMENT ALTERNATIVES

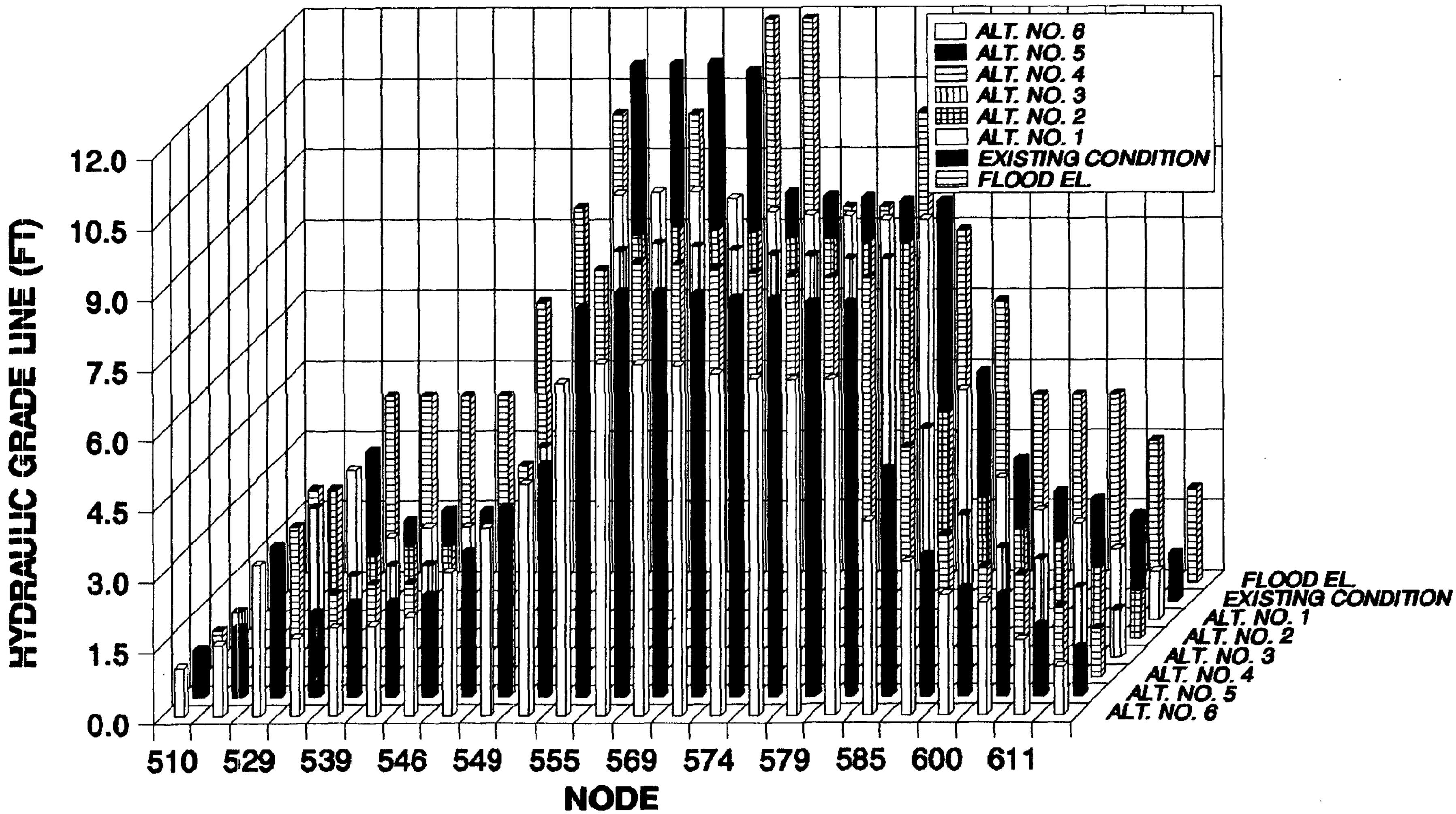
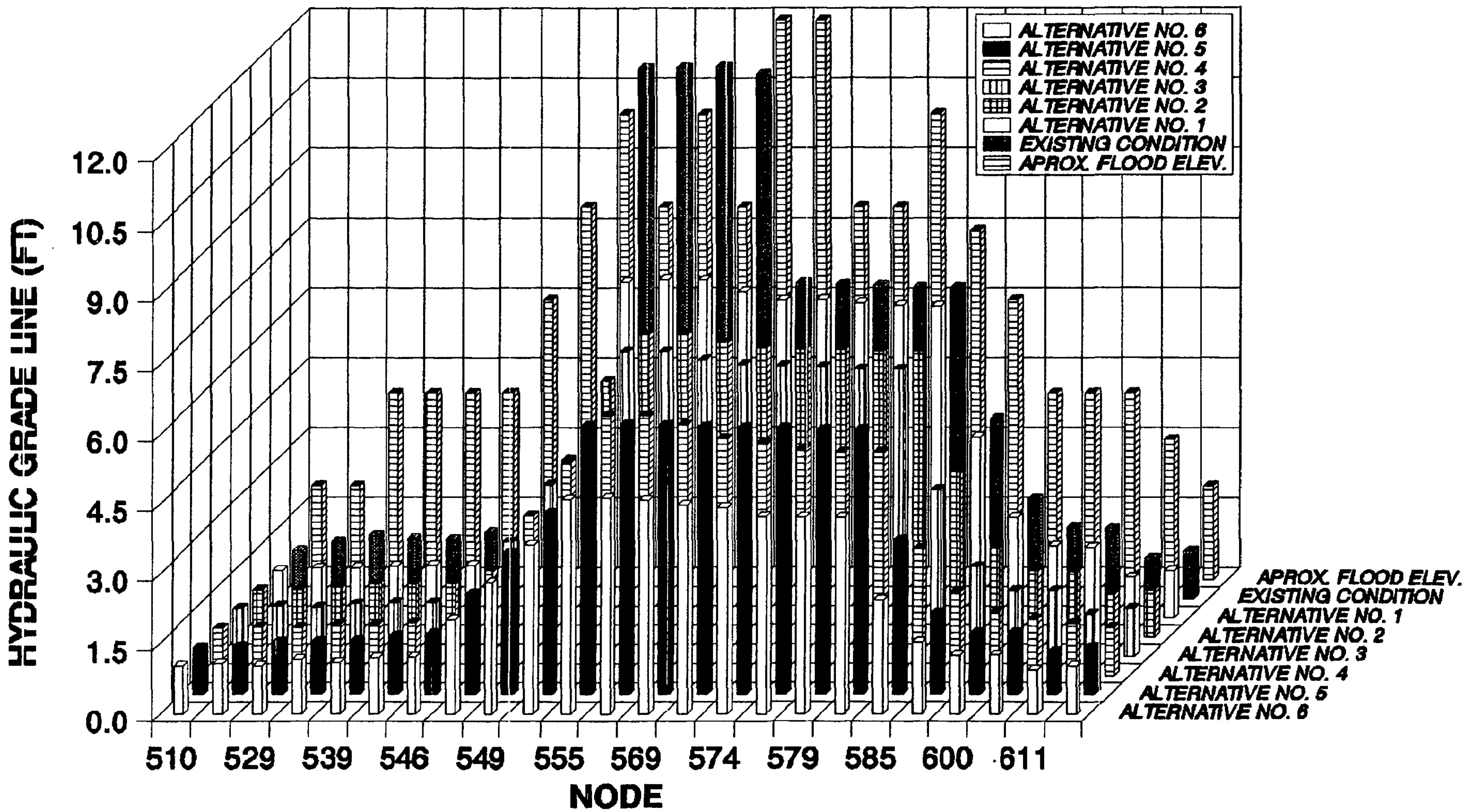


FIGURE 10

HYDRAULIC GRADE LINE @ TIME T = 4.0 HOUR FOR VARIOUS IMPROVEMENT ALTERNATIVES



alternative would be a reduction of the hydraulic grade line. The design storm event used in modeling the improvement alternatives was the 25 year, 4 hour duration storm event with a simulation time of 8 hours. The 4 hour duration event was determined as the storm event which resulted in the maximum water surface elevations for the existing system. The determination was made by a trial and error analysis of storm events with different times of duration. No attempt was made to verify that the same duration storm event will result in maximum water surface elevations once changes are made to the existing system. It is our opinion that the critical duration event for each alternative will not vary sufficiently from the 4 hour event to justify the additional time and expense necessary to determine the critical event for each improvement alternative.

Alternative No. 1

Alternative No. 1 consists of the removal of an obstruction in the canal system located adjacent to the City limits boundary, east of the 37th Street Bridge. The obstruction, denoted as Reach 1058 on Figure x, appears to have been caused by erosion and has resulted in a partial closing of the canal. Based on an analysis of the conveyance system, it appears that the removal of the obstruction results in an upstream decrease in the hydraulic grade line of 2.32 feet for maximum elevations and 4.19 feet at the time of 4 hours after the storm event began which is also the duration of the rainfall. We estimate that the cost of removal

FIGURE 11

MAXIMUM HYDRAULIC GRADE LINE
ALTERNATIVE NO. 1 VS. EXISTING CONDITION

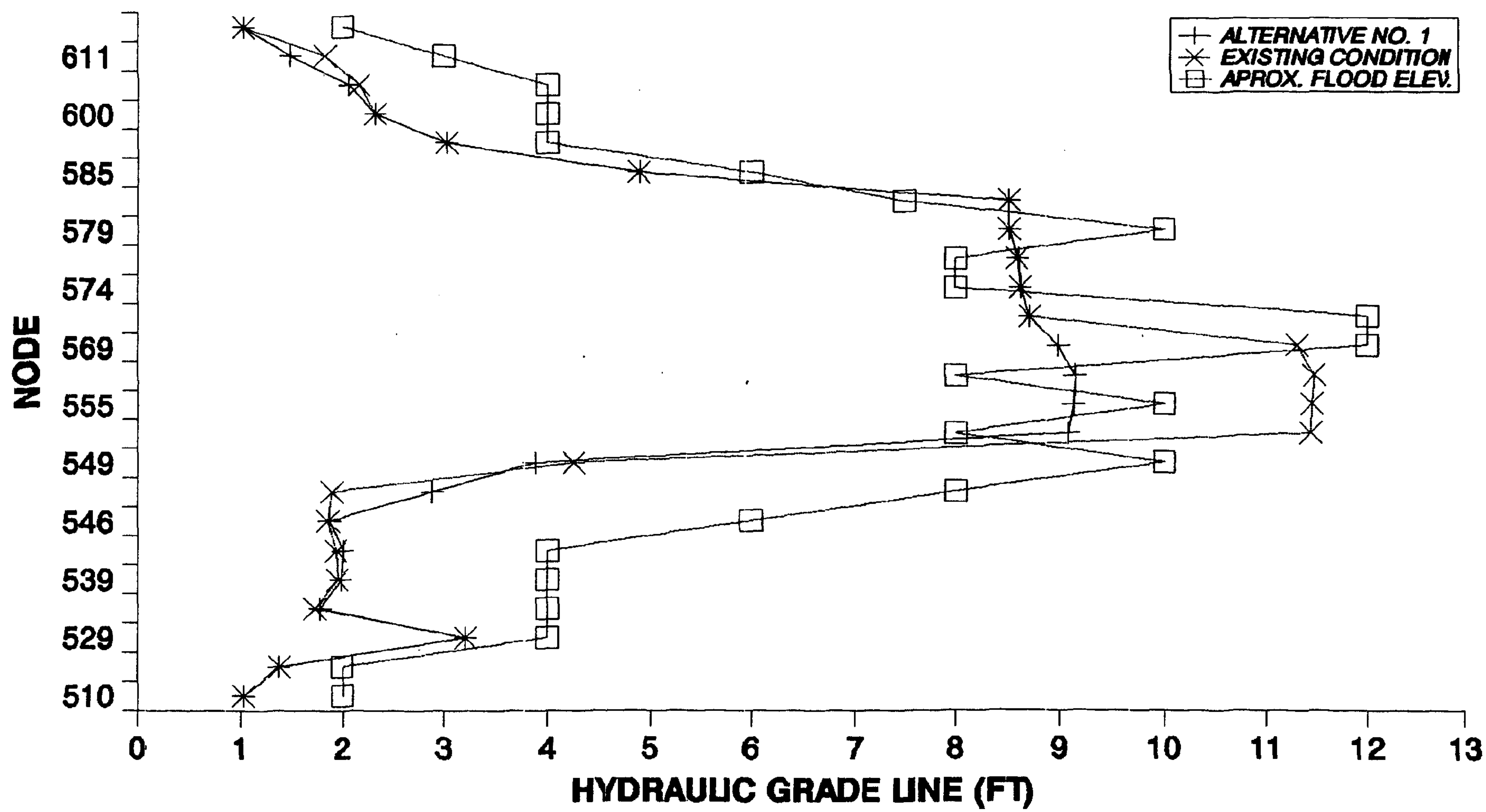
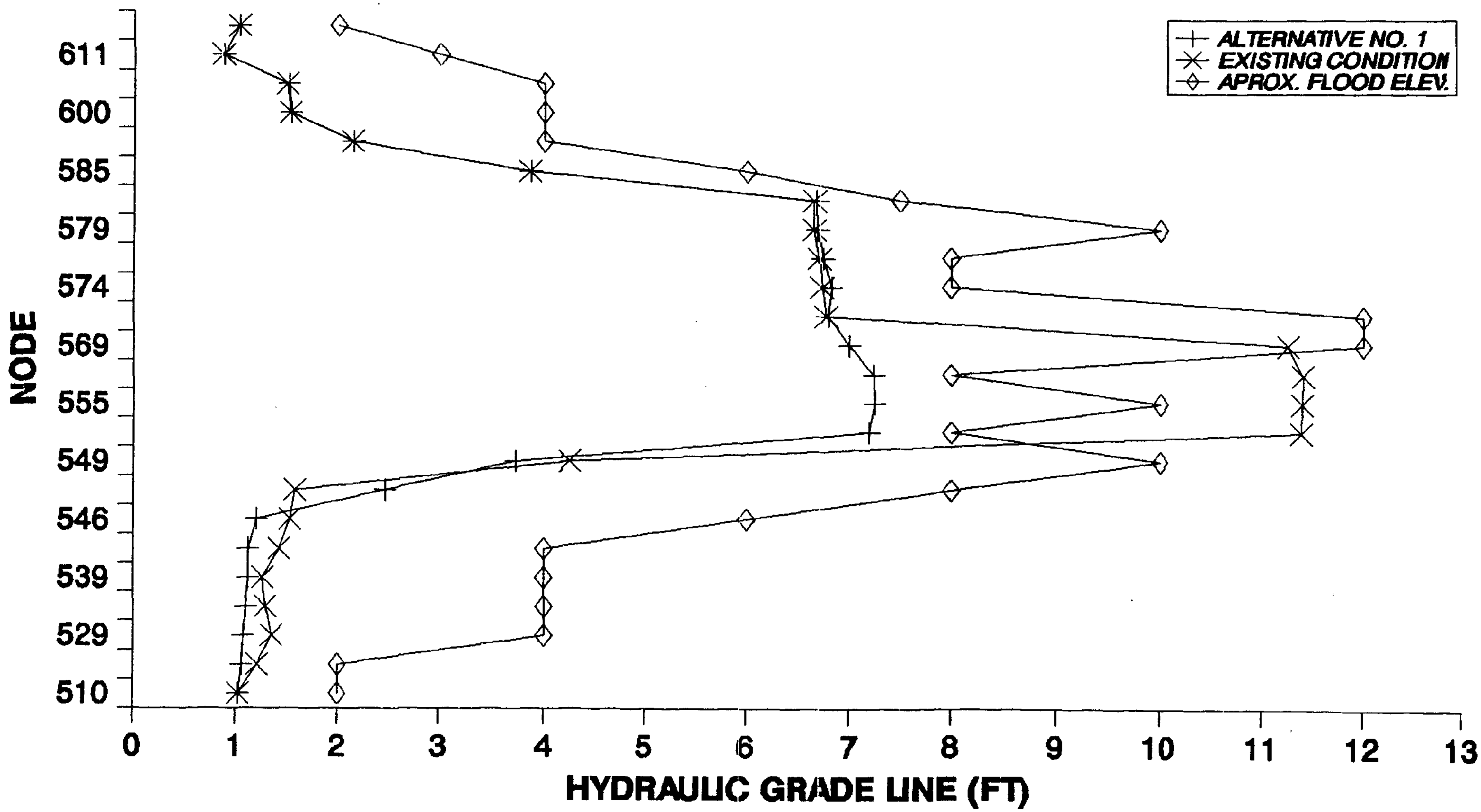


FIGURE 12

HYDRAULIC GRADE LINE @ TIME T = 4.0 HOUR ALTERNATIVE NO. 1 VS. EXISTING CONDITION



of the obstruction would be approximately $2,100.00. This would result in a very cost effective improvement to the conveyance system. Therefore, this obstruction should be removed and the section reshaped to match existing adjacent canal cross-sections.

The side slopes should be stabilized with vegetation.

Alternative No. 2

Alternative No. 2 consists of changing the 31st Street canal crossing from a 24 inch RCP to a 60 inch RCP in addition to the work of Alternative No. 1. The culvert crossing is denoted as Reach 1065 on Figure x. Based on an analysis of the conveyance system with the above noted modifications, it appears that the resultant hydraulic grade line will exhibit an upstream decrease for maximum elevations of 4.02 feet and at a time of 4 hours a decrease of 5.89 feet. We estimate that in addition to the cost of Alternative No. 1, the cost for replacing the crossing with a 60 inch RCP would be approximately $21,500.00.

Based on the effect of this alternative on the hydraulic grade line, we recommend that the City of Mexico Beach, as a minimum, consider replacing the 24 inch RCP. This culvert is severely undersized and was installed after completion of the canal system. The size was most likely selected based on economics. The result of this undersized culvert is that virtually all areas located to the east must discharge to the Gulf of Mexico at the

FIGURE 13

MAXIMUM HYDRAULIC GRADE LINE
ALTERNATIVE NO. 2 VS. EXISTING CONDITION

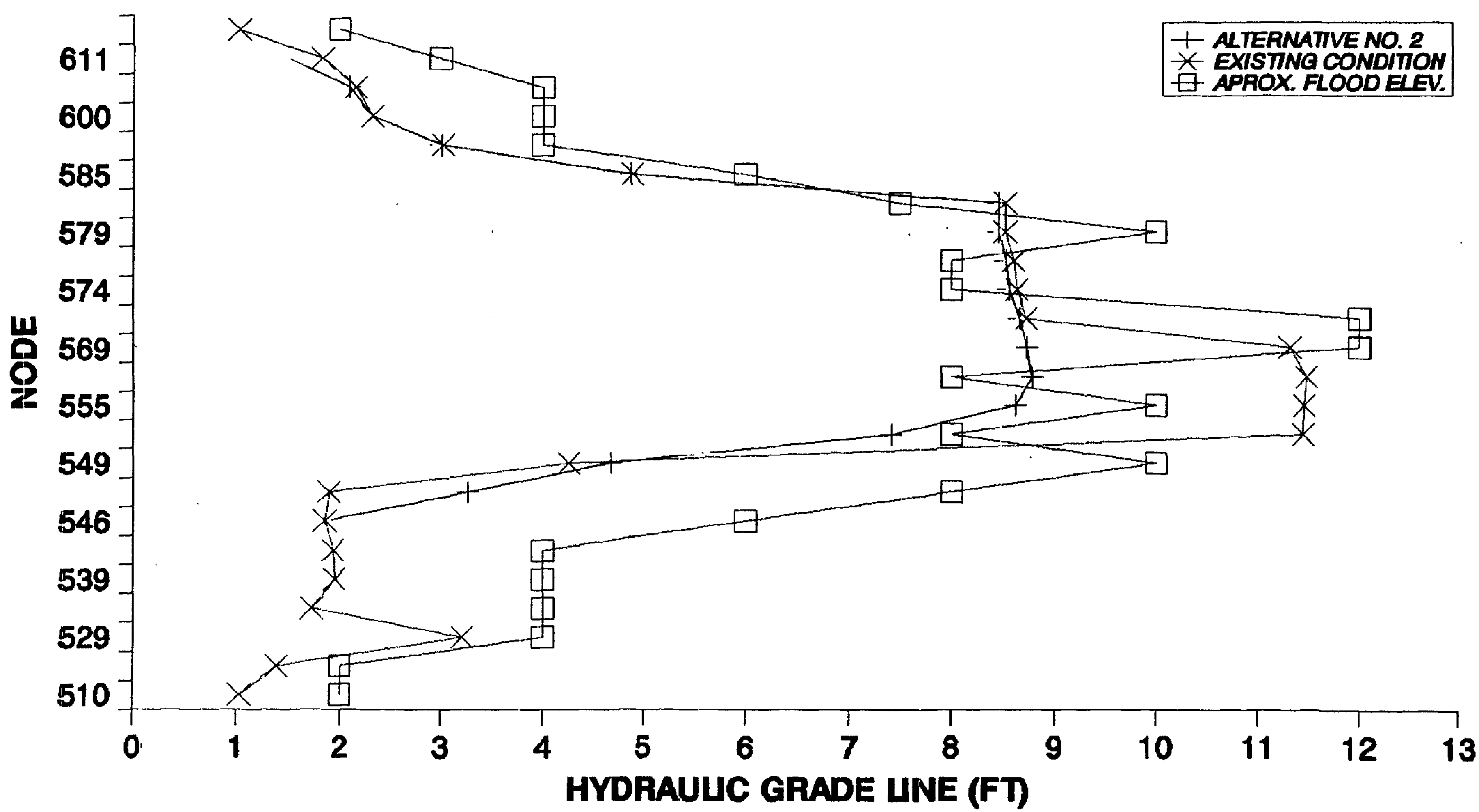
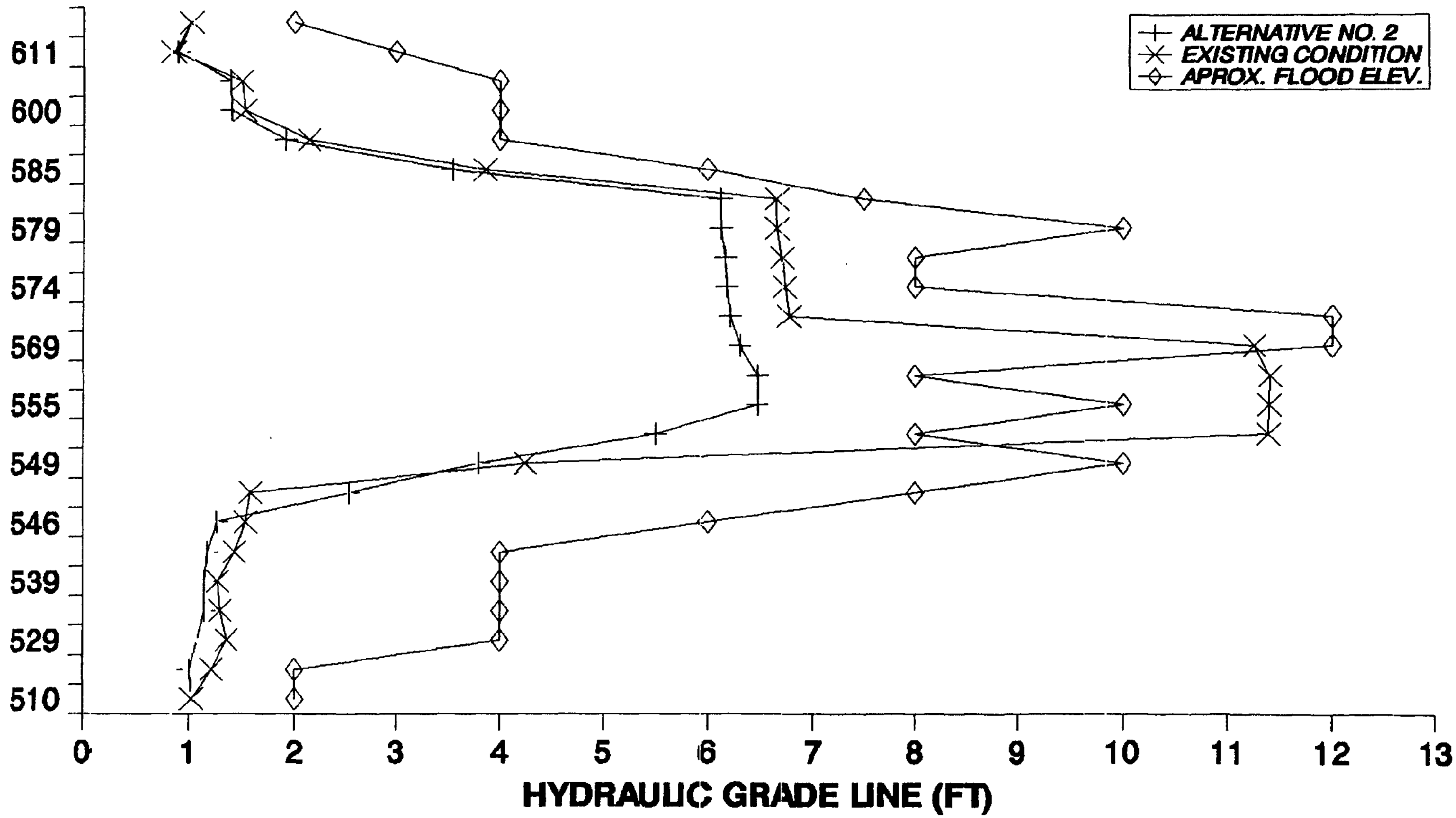


FIGURE 14

HYDRAULIC GRADE LINE @ TIME T = 4.0 HOUR ALTERNATIVE NO. 2 VS. EXISTING CONDITION



easternmost outfall. The best possible solution, which is considered as Alternate No. 3, would be to eliminate the canal crossing at this location and re-establish a uniform canal section.

Alternative No. 3

Alternative No. 3 consists of removing the 31st Street canal crossing, a 24 inch RCP, and reshaping the section to match existing adjacent canal cross-sections, in addition to the work of Alternative No. 1. Additionally, the side slopes of the reshaped section should be stabilized with vegetation. The crossing is denoted as Reach 1065 on Figure x. Based on an analysis of the conveyance system with the above noted modifications, it appears that the resultant hydraulic grade line will exhibit an upstream decrease for maximum elevations of 5.61 feet and at a time of 4 hours a decrease of 6.51 feet. We estimate that in addition to the cost of Alternative No. 1, the cost for removing the existing culvert and reshaping the section along with stabilization would be approximately $5,500.00.

We recommend that this alternative be selected over Alternative No. 2. The cost savings is substantial and this alternative is much more efficient resulting in a decrease in the hydraulic grade line of approximately 1.5 feet more than Alternative No. 2. It appears that alternate routes are available and removal of this crossing would not result in an adverse impact to traffic.

FIGURE 15

MAXIMUM HYDRAULIC GRADE LINE ALTERNATIVE NO. 3 VS. EXISTING CONDITION

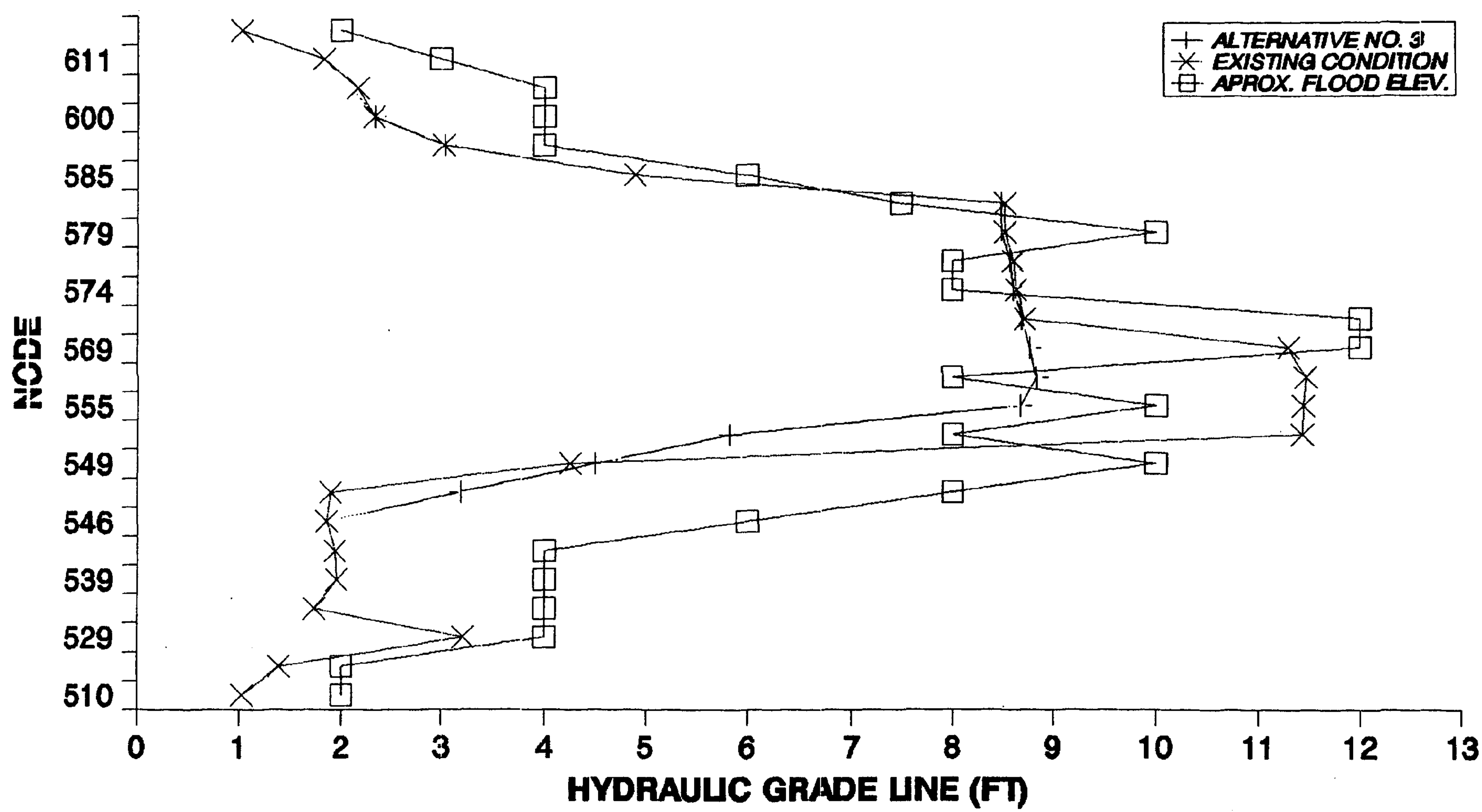
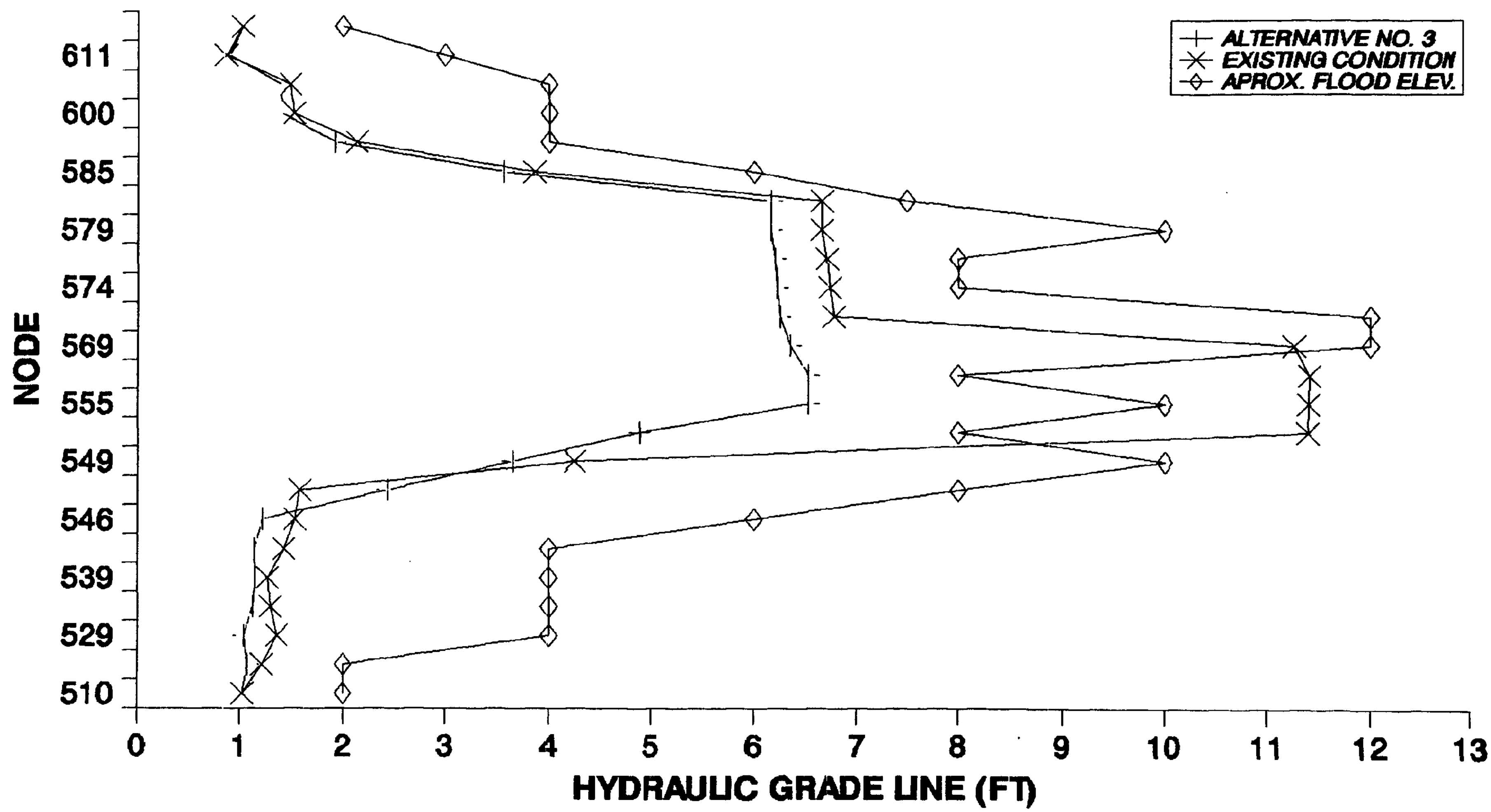


FIGURE 16

HYDRAULIC GRADE LINE @ TIME T = 4.0 HOUR
ALTERNATIVE NO. 3 VS. EXISTING CONDITION



Alternative No. 4

Alternative No. 4 consists of Alternative No. 3 and cleaning all portions of the conveyance system as described above. Based on an analysis of the conveyance system with the above noted modifications, it appears that the resultant hydraulic grade line will exhibit an upstream decrease for maximum elevations of 5.61 feet and at a time of 4 hours a decrease of 6.83 feet. Cleaning of the conveyance system does not exhibit any significant decrease in the hydraulic grade line for maximum elevations. However, it does result in a decrease in the hydraulic grade line throughout the overall duration of the storm event. Additionally, the value of this task goes beyond any decreases it causes in the hydraulic grade line as discussed above. Therefore, we believe that the execution of this alternative is necessary. We estimate that in addition to the cost of Alternative No. 3, the cost for cleaning the system would be approximately $161,000.00. Estimation of the costs for cleaning the system are difficult at best and should be considered as a rough estimate for planning purposes only. This estimate also assumes that the work would be contracted out. The costs would be substantially reduced if the work was performed by the City.

FIGURE 17

MAXIMUM HYDRAULIC GRADE LINE ALTERNATIVE NO. 4 VS. EXISTING CONDITION

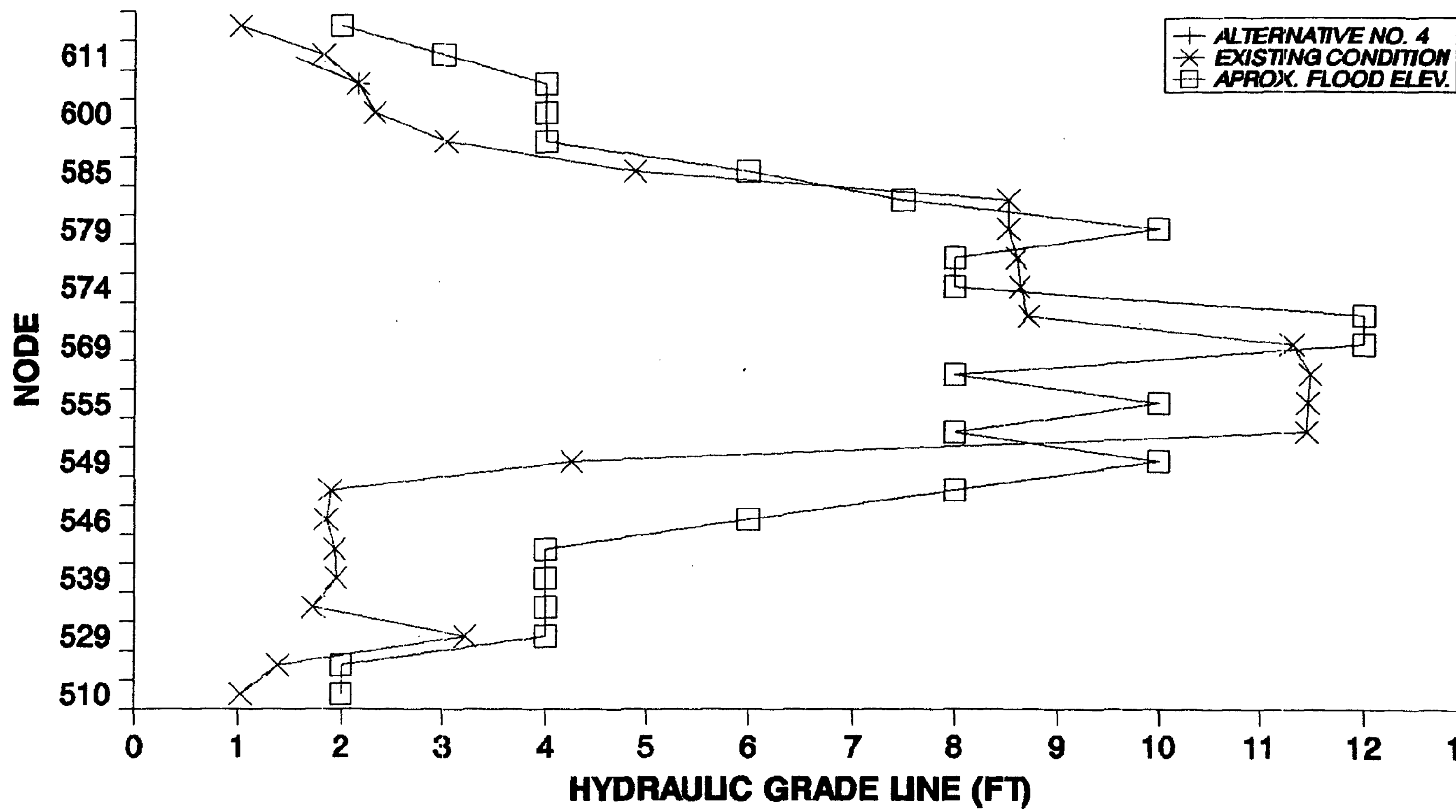
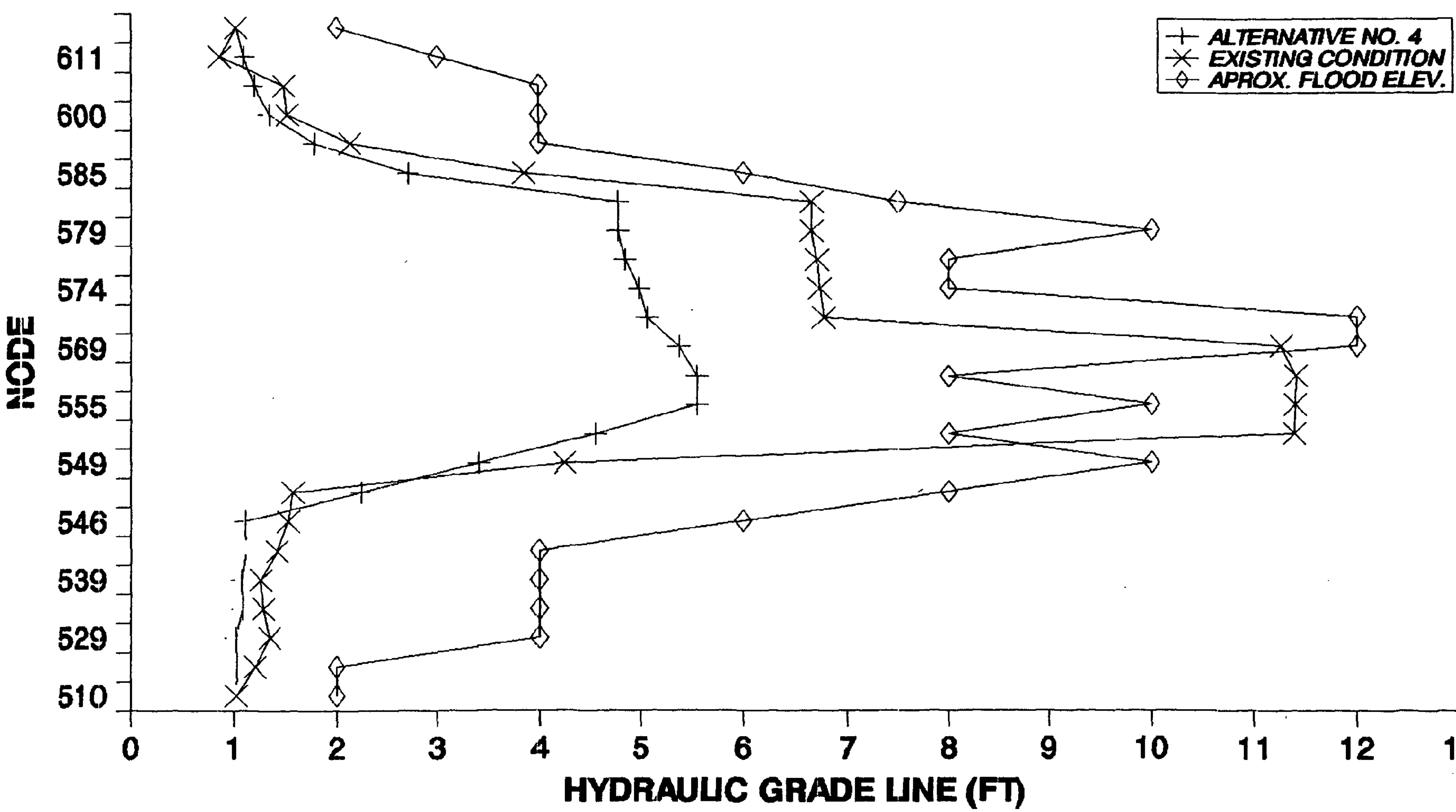


FIGURE 18

HYDRAULIC GRADE LINE @ TIME T = 4.0 HOUR ALTERNATIVE NO. 4 VS. EXISTING CONDITION



Alternative No. 5

Alternative No. 5 consists of Alternative No. 3 along with the regrading of approximately 3400 linear feet of canal from 31st Street to 19th Street. These sections of canal are denoted as Reach 1067 and Reach 1070 on Figure x. These two sections, or portions of the sections, of canal are at a significantly higher elevation than the remainder of the canal. This results in an obstruction or hindrance to stormwater flow, thereby, decreasing the efficiency of over one-half of the system. Based on an analysis of the conveyance system with the two sections regraded, it appears that the resultant hydraulic grade line will exhibit a decrease in the maximum elevation of 6.51 feet and at a time of 4 hours a decrease of 7.51 feet from the elevations of the existing system. It is probable that the entire lengths of the sections would not need to be regraded in order to increase the depth to an elevation consistent with the remainder of the canal system. We estimate that the necessary additional excavation is approximately 2 feet. An accurate estimate of the cost for regrading the two sections would not be possible without a more accurate survey of the two sections such that the actual areas which need to be deepened could be defined. However for planning purposes we estimate the costs for regrading the two sections would be approximately $60,000.00. It should be noted that the anticipated work could most likely be done as part of the cleaning of the system and a majority of the cost associated with that task.

FIGURE 19

MAXIMUM HYDRAULIC GRADE LINE
ALTERNATIVE NO. 5 VS. EXISTING CONDITION

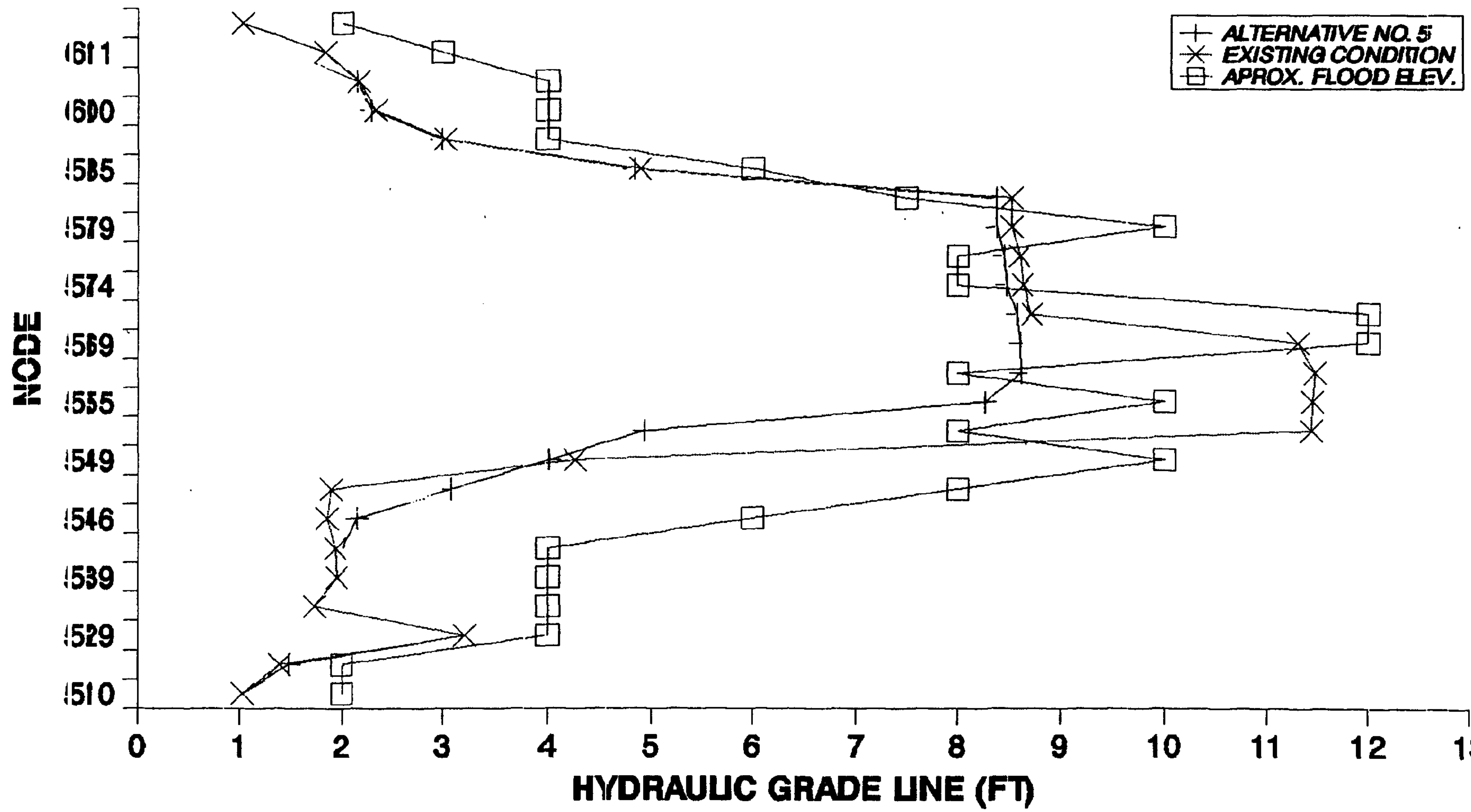
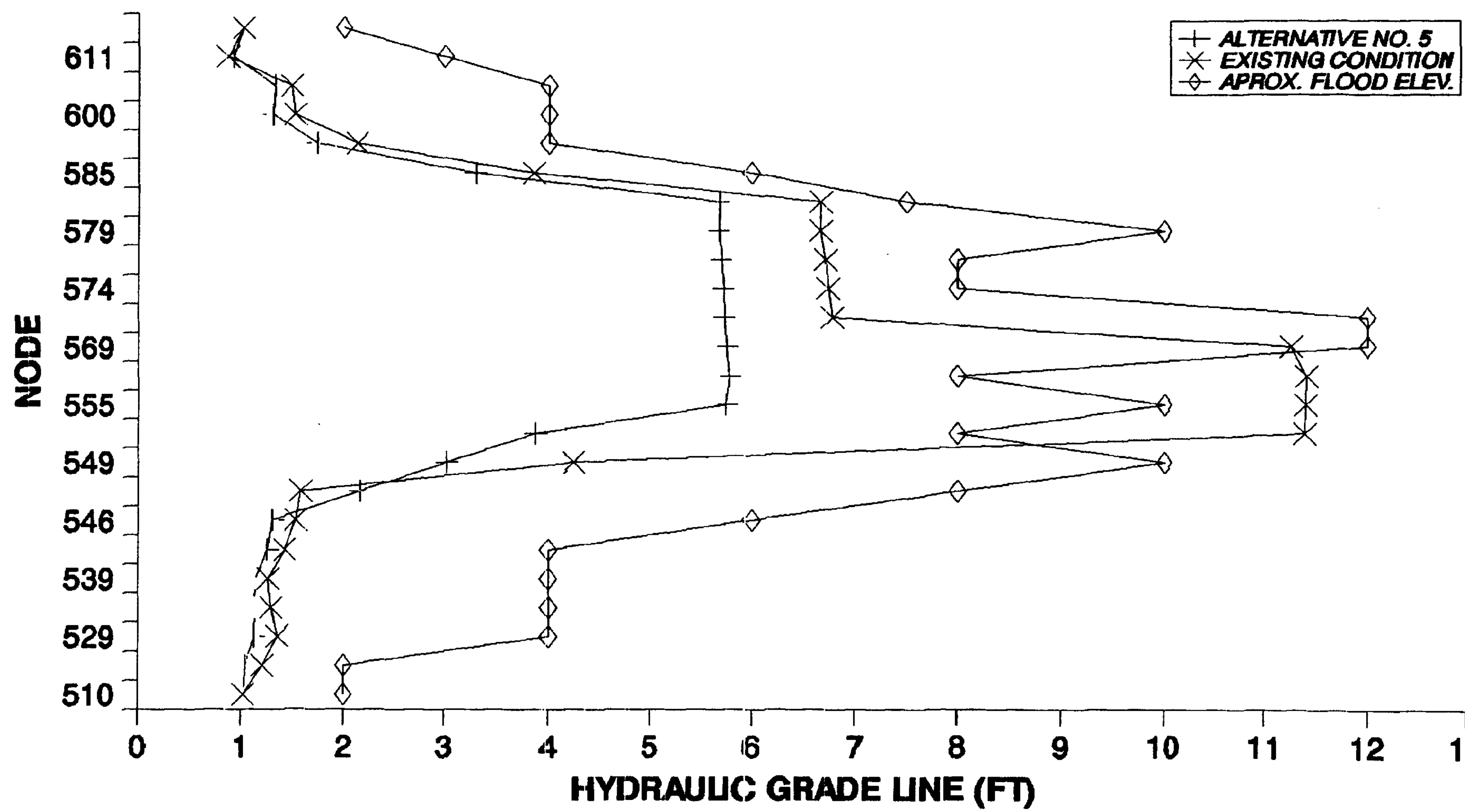


FIGURE 20

HYDRAULIC GRADE LINE @ TIME T = 4.0 HOUR
ALTERNATIVE NO. 5 VS. EXISTING CONDITION



Alternative No. 6

Alternative No. 6 consists of Alternative No. 5 along with cleaning of the conveyance system. This alternative represents a combination of the recommended changes to the system and demonstrates the overall anticipated improvements in the performance of the system. Based on an analysis it appears that the resultant hydraulic grade line will exhibit a decrease in the maximum elevation of 6.53 feet and at a time of 4 hours a decrease of 7.78 feet from the elevations of the existing system. Costs associated with the tasks of this alternative may be derived by addition of the costs for the previous alternatives.

7.3 STORMWATER IMPACTS

Stormwater impacts from future development within the City are anticipated to have little overall effect to the existing system. This is primarily a result of the large amounts of off-site property which are tributary to the system and account for a majority of the stormwater. The largest potential impact to the stormwater management system from development is not from the associated runoff but from the potential physical damage to the system itself. Examples of items which could have adverse impacts on the system include additional crossings which constrict flow, erosion from points of discharge, etc.

FIGURE 21

MAXIMUM HYDRAULIC GRADE LINE
ALTERNATIVE NO. 6 VS. EXISTING CONDITION

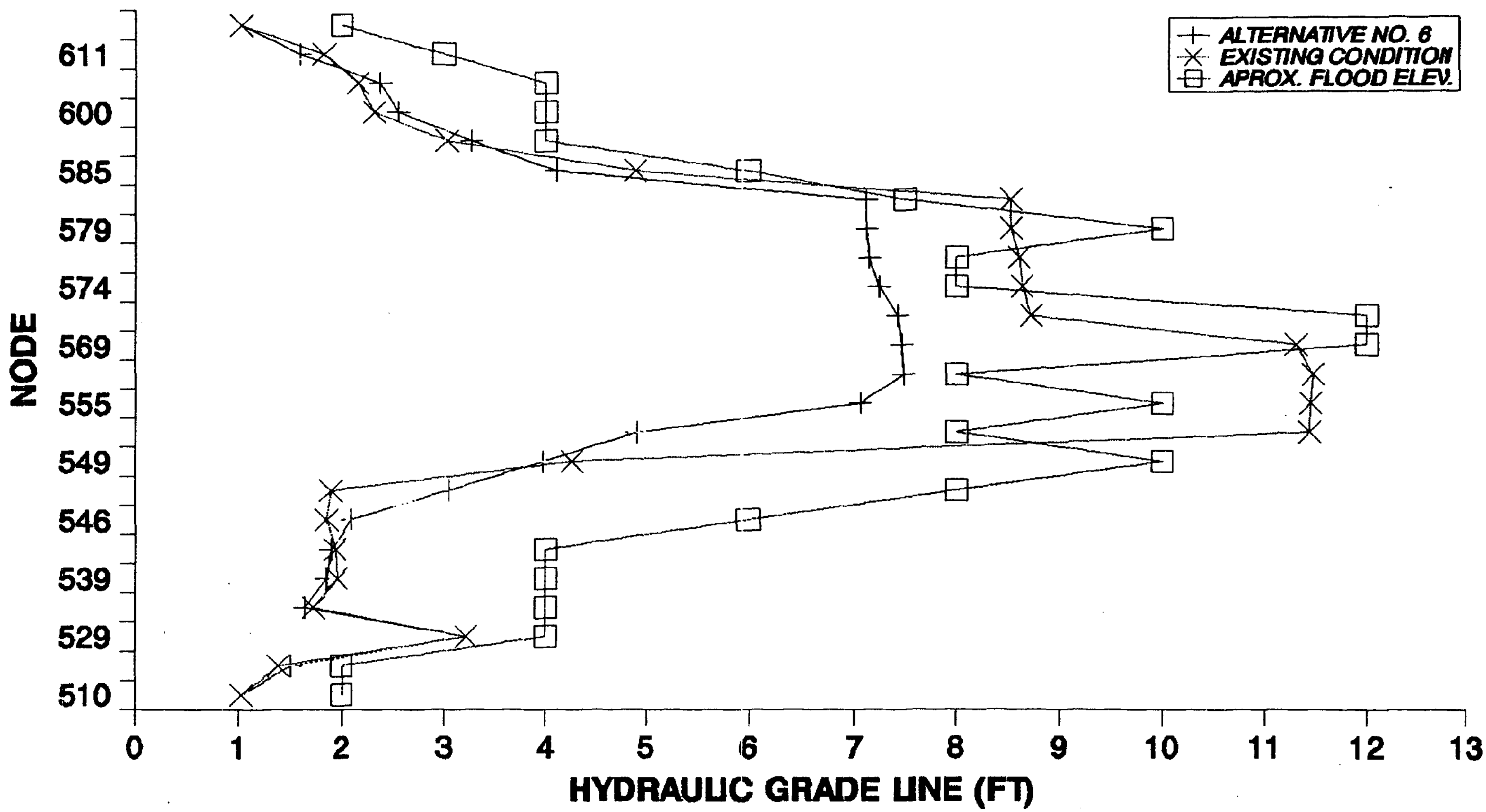
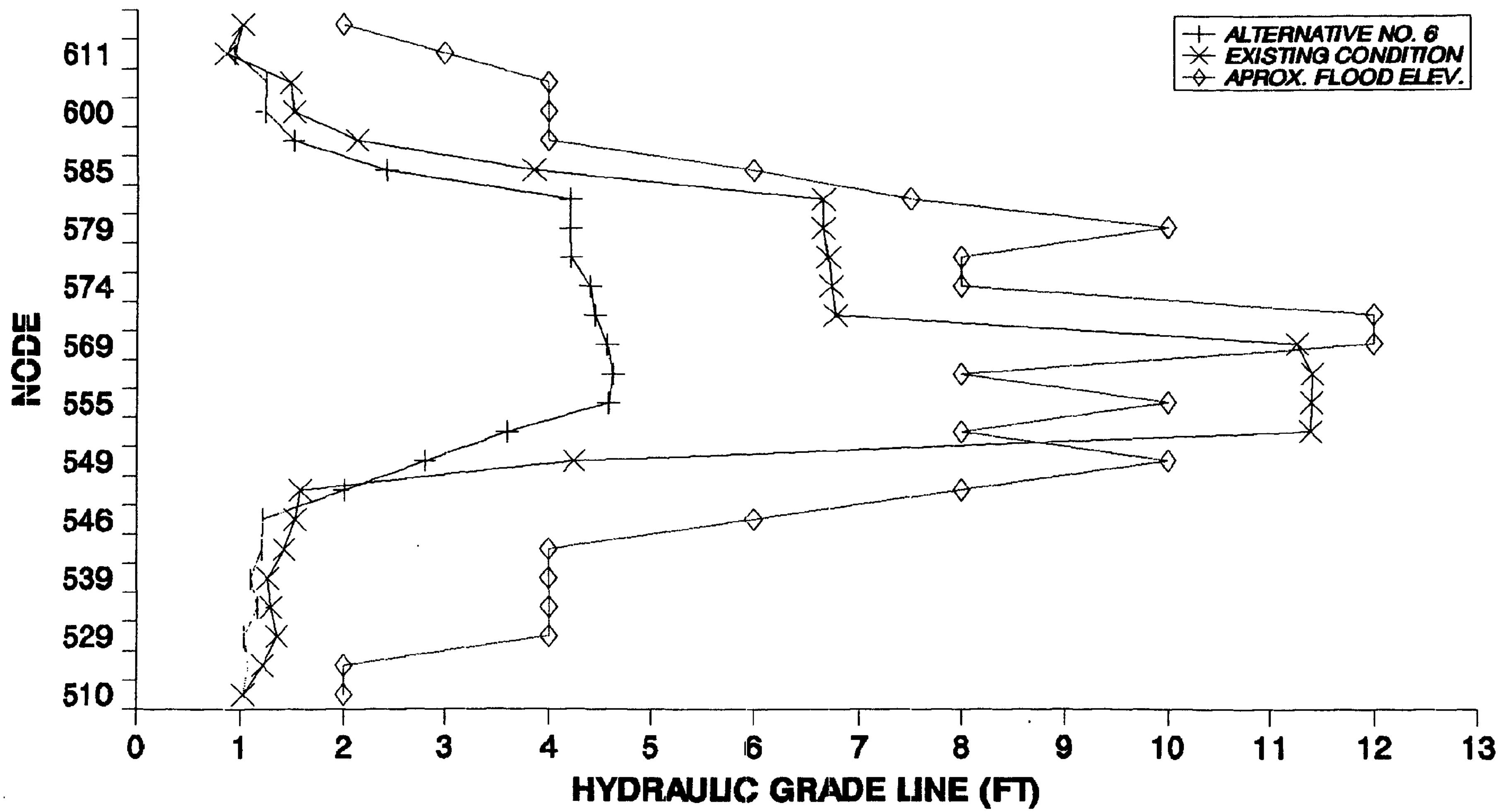


FIGURE 22

HYDRAULIC GRADE LINE @ TIME T = 4.0 HOUR
ALTERNATIVE NO. 6 VS. EXISTING CONDITION



Since it was anticipated that analysis results from future development would not differ significantly from existing conditions, improvement alternatives were not modeled using future land use parameters, except as necessary to verify this assumption. To verify the assumption an analysis was made of the existing system using future land use parameters. Results of the analysis and differences between the existing land use analysis may be seen by examining the hydraulic grade line elevations for each analysis show on Figure 23.

8.0 SURFACE WATER QUALITY

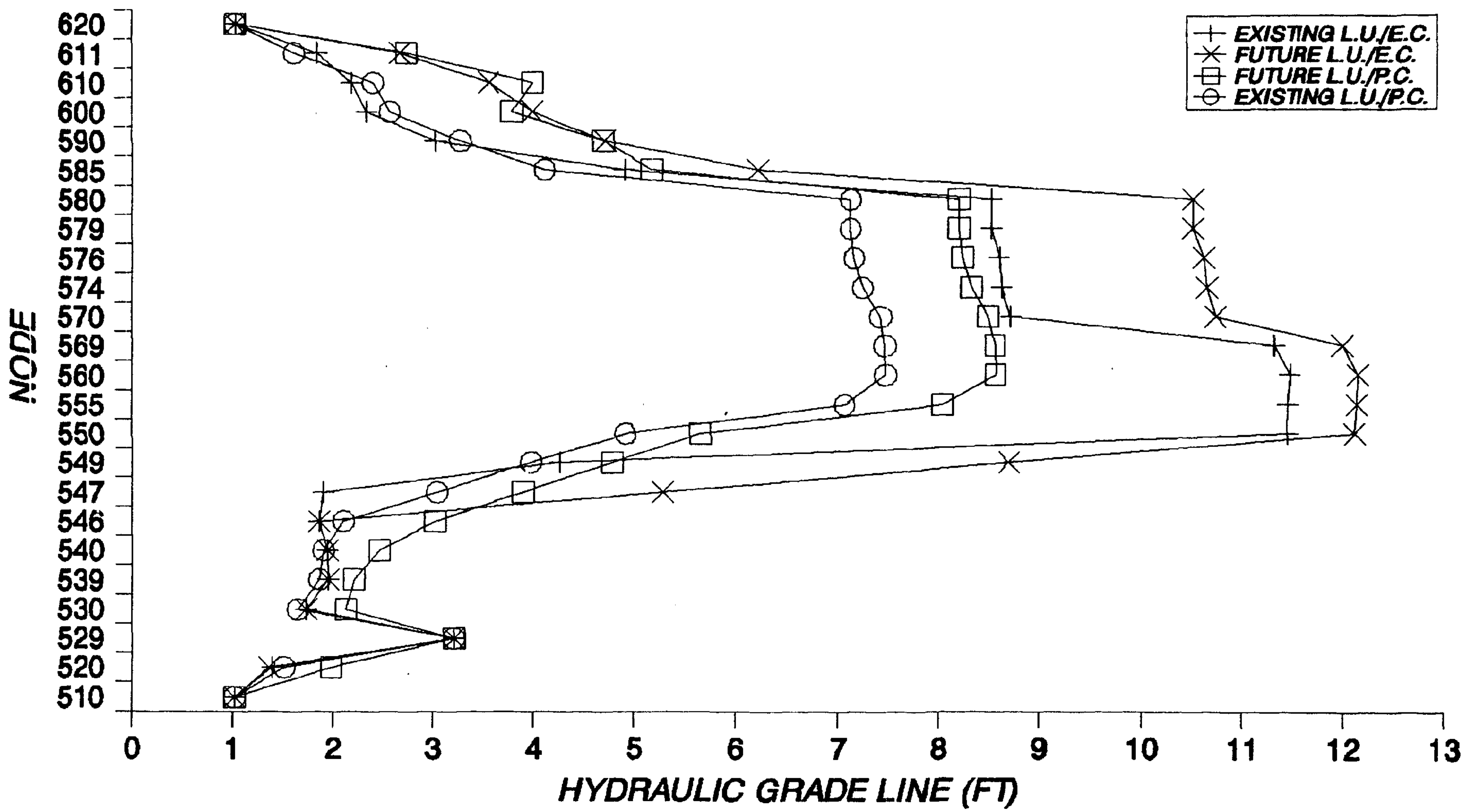
8.1 GENERAL

As previously discussed, a surface water quality analysis was not performed using the stormwater management model. Water quality was evaluated using a rational analysis. The analysis attempted to identify existing and potential nonpoint sources of pollution and recommend practices to reduce degradation of surface waters.

Generally the quality of surface water should approximate the quality of precipitation. Exceptions occur when the quality is degraded or enhanced due to local features, either natural or unnatural. An example of a naturally occurring degradation or enhancement would occur when another naturally occurring source of water of greater or lesser quality mixed with the surface

FIGURE 23

EXISTING LAND USE VS. FUTURE LAND USE



L.U. - LAND USE
E.C. - EXISTING CONDITION
P.C. - PROPOSED CONDITION

water. An example of an unnatural degradation would be where rainfall runoff causes agricultural pesticides to wash into the surface water. Precipitation may also be a cause of degradation by depositing air borne pollutants into the surface waters.

In most circumstances the two primary categories of degradation to surface waters occur as a result of point and non-point source discharges. Point source discharges occur when pollutants are directly discharged to surface waters. An example of a point source discharge is when a wastewater treatment plant discharges reclaimed water or effluent to surface waters. Any resultant degradation comes from an identifiable, singular point, with known impacts, i.e. a point source. Nonpoint source pollution of surface waters is best described as a category of pollution which includes various sources of pollution generally not attributable to singular, identifiable point sources and are most often transmitted by surface runoff. The pesticide degradation previously described is a nonpoint source discharge. Stormwater management systems are predominantly concerned only with nonpoint source pollutants.

The pollutants from nonpoint source discharges are classified as sediments, nutrients, potential toxins, pathogens, heavy metals, and organic compounds.

8.2 SEDIMENTS

Sediment is the single largest pollutant by weight of the nation's surface waters, exceeding the entire sewage load by 500 to 700 times. It has been estimated that in excess of $500 million is spent annually to remove sediment from surface waters.

The adverse effects of sediment include increased turbidity in the receiving water, filling of conveyances and surface waters, damage to aquatic organism food sources and spawning areas, and modification of the oxygen content of the surface water. Additionally, sediment may carry other pollutants such as heavy metals, pesticides, and organic compounds which attach themselves to the surface of the eroded particle.

Erosion or sediment transport is a naturally occurring phenomenon and a certain amount should be expected to enter the surface waters. However, due to the activities of man the amounts of sediment transport is in most areas many times greater than naturally occurring levels. Examples of events which have caused this increase include construction activities leaving exposed soil areas, unplanted agricultural areas, vegetative changes for soil type, modifications to natural drainage features, uncontrolled erosion and inadequate maintenance of conveyance systems, etc.

Based upon our analysis, sediment transport is the largest single contributor to degradation of the stormwater management system and surface waters of the City of Mexico Beach. It has resulted in a decrease in efficiency of the conveyance system by filling in portions of the canal system, creating obstructions, and increasing the turbidity of the surface waters. We also believe that sediment transport from stormwater runoff is contributing to the problems associated with the primary inlet to the Gulf of Mexico. The exact contribution to the inlet problems cannot be determined at this time and the majority of the sediment transport affecting the inlet is most likely a result of lateral drift from the Gulf of Mexico. However, a reduction of sediment transport from stormwater runoff should result in a decrease in efforts to maintain the inlet.

8.3 NUTRIENTS

The primary nutrient constituents are nitrogen and phosphorus. These nutrients are generally derived from agricultural chemicals, detergents, and animal waste. The entry of nutrients into surface water can increase algal activity, result in noxious odors, and reduce the oxygen content of the water.

Based upon our analysis we would not expect high concentrations of unnaturally occurring nutrients. The majority of the nutrients which will be transported to the surface waters will be from animal wastes and fertilizers along with other household agricultural products.

8.4 POTENTIAL TOXINS

Potential toxins found in stormwater are generally from pesticides and chemical compounds of industrial and commercial origin. Pesticides vary greatly in strength, formulation and toxicity. Some of the organochloride pesticides are extremely resistant to decomposition and can remain in the environment for more than 20 years creating a health hazard for all organisms. While most of these types of pesticides are no longer in use they still represent a potential problem due to their persistence.

Potential toxins from industrial and commercial sources include illegal dumping and discharge of waste products such as acids, some paints and discharges from industrial processes either by airborne pollutants or point source discharges. Examples of these type of toxins are PCBs and dioxin.

Based upon our analysis we would not expect unusually high concentrations of toxins in the system. However, it should be noted that some toxins in minute quantities are most likely present. We believe that the most likely source for any toxins would be air borne pollutants from the paper mills and chemical plants in the area. It is doubtful that toxins exist in the system in sufficient quantities to pose a threat to the health and safety of the public.

8.5 PATHOGENS

Pathogenic hazards associated with surface water quality are a result of bacterial contamination. The primary source of bacterial contamination is from human and animal wastes. Resulting diseases include anthrax, encephalitis, tetanus, histoplasmosis, leptospirosis, bronchitis, and salmonellosis.

While pathogens present a significant hazard to public health and safety, rarely do they represent a real hazard except to public water supply, and livestock. Also, human and animal wastes are one of the simplest substances to decompose. An analysis of pathogenic hazards is not possible. The potential for hazards may exist due to extensive use of septic systems in the City.

8.6 HEAVY METALS

Heavy metals found in stormwater runoff include cadmium, copper, chromium, lead, nickel, mercury, and zinc. The primary source for heavy metals in stormwater runoff is runoff from streets. In surface waters marine traffic can also contribute to the deposition of heavy metals. Heavy metals are a byproduct of vehicular traffic and the internal combustion engine. The predominant heavy metals found are lead and zinc. The results of high concentrations of heavy metals are devastating to organisms with concentrations increasing through transmittal to higher species through the food chain. However, the effects of low concentrations over long periods of time is less well documented. Heavy metals tend to settle out of surface waters and collect in the sediment deposited on the bottom. From time to time these metals can be resuspended in the water column through disturbance. In areas with high traffic, both vehicular and marine, the concentrations of heavy metals in the sediments could exceed safe levels.

Based upon our analysis we do not anticipate that the concentrations of heavy metals in stormwater runoff is excessive. We do believe that a potential exists for high concentrations of heavy metals in the sediments of portions of the canal system subject to heavy marine traffic. It is our opinion that these heavy metals are the result of low concentrations over a long period of time and that they do not represent a significant hazard at the present time. However, we would advise that before any dredging is done in the canal system where marinas, docking or fuel facilities exist that sediment samples be analyzed for heavy metals. In the event that heavy metals are present in significant concentrations the spoil material will need to be disposed of in an appropriate manner.

8.7 ORGANIC COMPOUNDS

Organic compounds in stormwater runoff and surface waters include oxygen consuming material which can deplete the oxygen content of the water. If the oxygen content is sufficiently reduced marine organisms will perish. Quantitative measures of the potential impact on a receiving water is expressed by biochemical oxygen demand (BOD) and by chemical oxygen demand (COD) for non-biodegradeable compounds. The BOD and COD measure the amount of oxygen consumed in the decomposition process.

Based upon our analysis we do not anticipate that BOD and COD will exceed normally anticipated levels.

9.0 NONPOINT SOURCE IMPROVEMENTS

It does not appear that any excessive nonpoint source pollutants are entering the system which need special attention except for sediment transport. The nonpoint source pollutants which are entering the system, including to a large degree sediment transport, can be reduced through the use of best management practices discussed herein.

In addition to best management practices for sediment transport, additional improvements need to be implemented. The actions recommended include the removal of existing deposits of sediment in the conveyance system which serve as a source for sediment transport and stabilization of the conveyance system. These improvements have been previously discussed as part of the system maintenance which is recommended.

10.0 BEST MANAGEMENT PRACTICES

Best management practices should be incorporated into the stormwater management system to reduce the levels of pollutants entering the system from existing sources. Policies should also be implemented to require best management practices to prevent or decrease impacts from future sources. Best management practices or BMPs are a term allocated to certain practices which have been found efficient in the removal of pollutants on a per unit cost basis. BMPs can be divided into two general improvement methods, structural practices and non-structural practices, for reducing or preventing pollution.

10.1 NON-STRUCTURAL BMPS

Non-structural BMPs are practices which minimize or prevent pollution before transport to the receiving water or primary conveyance system. These practices address sources of pollution at the furthermost upstream point.

1. Street Cleaning

Street cleaning through the use of mechanical or vacuum sweepers can remove litter, dust and dirt from street surfaces. Varied rates of success have been achieved with different types of sweepers with the best results being obtained using the vacuum type sweepers. While sweeping can be effective, it does not remove any pollutants except those located on the street surfaces. The greatest benefit from this practice would occur on heavily traveled urban streets. It is our opinion that street weeping at this time would not be cost effective in reducing pollutants from entering the stormwater management system. However, street sweeping may be an effective alternative in the future as development progresses. Particularly if streets can be identified which contribute heavy loads of pollutants.

2. Erosion/Sedimentation Control

Erosion/Sedimentation control measures should be implemented to reduce or prevent sediment from exposed ground surfaces, construction activities, and poorly constructed and maintained drainage conveyances from discharging to the surface waters. Ordinances should be enacted and enforced to prevent sediment from discharging from exposed ground surfaces and construction activities. As previously discussed, existing conveyances systems should be examined for locations of erosion and maintenance procedures taken to stabilize those areas. Future construction of conveyance facilities should be required to stabilize those facilities with either structural or vegetative means with vegetative means being encouraged.

10.2 STRUCTURAL BMPS

Structural BMPs are practices which minimize or reduce pollution through physical modifications. These practices address specific problem areas.

1. Detention/Retention Basins

Detention/Retention basins are large pond like structures which are constructed to treat and/or attenuate stormwater runoff. Treatment of the stormwater is achieved through settling, biological assimilation and possibly filtration. Stormwater attenuation may be achieved by designing a detention facility large enough to store a portion of the runoff and discharge it downstream at a reduced rate. Detention/Retention basins are the primary treatment facility in use for stormwater management.

Based upon our analysis the use of detention/retention basins will be most applicable to future development. The City presently has a well defined conveyance system which if modified with the recommended improvements will not need additional attenuation facilities to reduce flooding of the system. Detention/Retention facilities could be used in the future if locations are identified where flooding or sediment is being introduced to the system at a known point.

2. Sedimentation Basins

Sedimentation basins are similar to Detention/Retention Basins in that they are large structures through which stormwater runoff is directed. The primary difference is they are designed to specifically target sediment for removal. This is accomplished by reducing the velocity of the incoming runoff such that any suspended particles will settle out prior to discharge. Sedimentation basins may be of a long linear shape or more uniformly rectangular or round.

The primary benefit of sedimentation basins for the City would be in their installation at points along the existing conveyance system to trap sediment and reduce maintenance efforts. Potential locations for such facilities would be at points of connection for minor ditch systems to the major trunkline system. Construction would entail the over-excavation and widening a section of the ditch system for a sufficient length to reduce conveyance velocities to less than the settling velocities of any suspended particles. In many instances this technique could be used without the need for additional property.

3. Swales

Swales are ditch sections which contain a top width-to-depth ratio of the cross-section equal to or greater than 6:1, or side slopes equal to or greater than 3 horizontal to 1 vertical, and is stabilized with vegetation. Swales have been found to be very effective in the removal of pollutants in areas with an appropriate underlying soil.

Based upon our analysis, swales would most likely be the treatment mechanism which could most benefit the City. Numerous streets exist with shallow roadside ditches. The City should consider implementing an improvement project which would reshape these roadside ditches to meet the swale requirements and stabilize them with sod. The benefits of such a project would be in reduced maintenance of both these ditches and downstream ditches. In many cases where shallow roadside swale sections are utilized the homeowner will maintain and mow the section thereby relieving the City of the majority of the maintenance requirements. Benefits downstream will be realized in a reduction in sediments and maintenance along with a reduction in other pollutants.

11.0 STORMWATER MANAGEMENT REGULATION*

Chapter 163.3177 F.S., requires that all local governments address stormwater management in "a general sanitary sewer, solid waste, drainage, potable water, and groundwater aquifer recharge element..." in their comprehensive plans. Rule 9J-5 F.A.C. further requires the development and implementation of a Level Of Service (LOS) standard for all such infrastructure. It defines the LOS standard as being "an indicator of the extent or degree of service provided by, or proposed to be provided by a facility based on and related to the operational characteristics of the facility". Rule 9J-5.003(23), (24) & (25) provide standards for the engineering-based operational characteristics of a facility's capacity to handle stormwater quantity (e.g. volume and rate of runoff from a site) and quality (e.g. reduction in the amount of pollutants carried off-site in the runoff). Such drainage facilities are among the public facilities required to meet the concurrency requirement (see. 9J-5.011(2)(c)2, F.A.C.). Thus, proposed developments that will, if approved, result in a lowering in the LOS below the level specified in the plan may not be permitted.

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* Adapted from: Land Development Regulations, Technical Assistance Manual, Center for Governmental Responsibility, University of Florida, 1989.

In addition to addressing the stormwater runoff issue in the required comprehensive plans, local governments must also deal with the issue in their land development regulations. Chapter 163.3202 F.S. provides that:

(2) Local land development regulations shall contain specific and detailed provisions necessary or desirable to implement the adopted comprehensive plan and shall as a minimum:

"(d) Regulate areas subject to seasonal and periodic flooding and provide for drainage and stormwater management;"

The state has now established a comprehensive regulatory program designed to address the need for effective management of stormwater runoff. A complex mosaic of regulations and regulatory entities has been developed to address the issue. Local governments addressing the issue in their required comprehensive plans and land development regulations must take into account the regulatory framework within which local requirements must operate.

The regulatory system already established for managing stormwater runoff at the state and regional levels of government were created to deal with the stormwater quality and quantity issues.

11.0 Stormwater Quality

An initial step toward addressing the water quality problems caused by nonpoint sources was taken in 1982 with the promulgation of Chapter 17-25, F.A.C. known as the Stormwater Rule, by the Florida Department of Environmental Regulation (DER) which is given responsibility to regulate stormwater discharges as a source of pollution (see, 403.087,.088 F.S.) The purpose of the rule is to prevent pollution of Florida waters by stormwater discharged from new, expanded or modified development. The rule establishes a minimum state-wide standard for all non-exempt construction to conform to. A performance standard is used which is designed to ensure that required stormwater systems remove at least eighty percent (80%) of the annual pollution load of the developed site. The rule permits delegation of stormwater quality assurance permitting to the water management districts or local governments. Except for the Northwest Florida Water Management District, all of the water management districts have accepted this delegation. The permitting requirements for meeting stormwater quality standards compliment previously existing stormwater quantity standards administered by the water management districts implementing Part IV of Chapter 373 F.S. discussed next.

11.2 Stormwater Quantity

Part IV of Chapter 373 F.S. requires regulation of the construction, alteration, maintenance, operation, and abandonment of "dams," "appurtenant works," "Impoundments," "reservoirs," and "works" affecting waters in the state. Thus, virtually all types of real property improvements that are intended to or have the effect of controlling, diverting, or impounding surface waters, fall within the purview of this law. The surface water management called for under Part IV and the implementing rules, are intended to protect against flooding and provide protection of existing upstream and downstream flows.

Rule 17-40 F.A.C. provides guidelines for implementing Part IV of CHapter 373. The rule establishes surface water management requirements and criteria for establishing minimum flows and levels pursuant to Section 373.042 F.S. Each of the water management districts are required to develop water management plans consistent with the rule and Section 373.036 F.S. A review by DER of existing water management district rules is required to determine their consistency with 17-40 F.A.C. The DER has conducted that review and determined all existing water management district programs to be consistent. Pursuant to the rule, all districts with permitting programs have been delegated the responsibility to implement the program.

Under the program, all non-exempt projects which entail the construction and operation of facilities which manage or store surface waters, or other facilities which drain, divert, impound, discharge into, or otherwise impact waters of the state must be permitted by the water management or the DER (17-40.070) district with jurisdiction or the DER (see 17-40.070 F.A.C.). Statutory exemptions are provided for; certain soil-related involving agriculture, floriculture, silviculture, and horticulture; certain agricultural closed systems; and the right of any natural person to capture, discharge, and use water for purposes permitted by law (Section 373.409 F.S.).

11.3 Local Regulation

All Florida local governments are required to address stormwater management in their comprehensive plans and land development regulations. The requirements established in the drainage and capital improvement elements of the comprehensive plan will largely determine what will be required in the development regulations. For many localities, it may be possible, and in some cases necessary, to rely upon the substantive requirements of the DER and water management district to address stormwater quantity and quality.

Rule 9J-24 F.A.C., which establish the procedures and criteria for review of local government land development regulations, requires the inclusion of "specific programs, activities, standards, actions or prohibitions which regulate or govern the ... provision of adequate drainage facilities to control the individual and cumulative impacts of flooding and non-point source pollution in drainage basins existing wholly or in part within the jurisdiction." Thus, the land development regulations adopted pursuant to Section 163.3202 F.S. and Rule 9J-24.033 F.A.C. must address both the water quantity and quality aspects of stormwater management.

Since existing laws require inclusion of stormwater provisions in local land development regulations, and all such regulations must be incorporated into a single code, the stormwater regulations included herein are intended to be a section of the overall land development regulations rather than a separate ordinance. The City will prepare and submit its land development regulations to DCA before December 1, 1990.

The following stormwater regulations are intended to address both the quantative and qualitive aspects of stormwater management. These regulations are further intended to be realistic to the limited financial and administrative resources available to the City for regulating stormwater.

It should be noted that the format of these model regulations may change as dictated by the construction of the land development regulations. Specific requirements and design criteria will remain the same unless changes occur in governing laws during the coming year.

11.4 MODEL STORMWATER MANAGEMENT PROVISIONS

XX.01 Public Purpose

The discharge of untreated and uncontrolled stormwater can reasonably be expected to be a source of pollution to waters of the state, and a direct cause of flooding causing risk of harm to life and property. It is the intent of the City to minimize adverse impacts of pollution and flooding through regulation of stormwater discharges caused by land development.

xx.02 Exemptions

The following development activities are exempt from the requirements of subsection xx.03, except that measures to control erosion and sedimentation must be undertaken for all development when considered necessary by the City.

1. Individual single-family, duplex, tri-plex and quadraplex residential dwelling units constructed on a single lot or parcel of land, provided the individual single-family, duplex, tri-plex or quadraplex structure is not part of a larger common plan of development or sale.

2. Accessory buildings or structures constructed in conjunction with single-family, duplex, tri-plex or quadraplex residential dwelling units.

3. Any development within a residential subdivision provided the following conditions have been met:

a) A stormwater management facility which has been constructed in conformance with the standards prescribed in this section is available to receive stormwater discharges;

b. The development will be constructed in accordance with the stormwater management provisions approved as a larger common plan of development or sale provided such provisions are valid as part of a final development order or agreement and comply with the provisions of this Section;

c. Applicable exemptions as specified in Subsection 17-25.030, Florida Administrative Code (DER Stormwater Permit).

d. Applicable exemptions as specified in Subsection 14-86.003, Florida Administrative Code (FDOT Drainage Connection Permit).

xx.03 Stormwater Management Requirements

All non-exempt development activities must be designed, constructed, and maintained in accordance with the provisions of this subsection.

x.031 Design Standards

1. Water Quality

   At a minimum, all non-exempt stormwater management facilities shall be designed, constructed and maintained in conformance with the provisions of Chapter 17-25, Florida Administrative Code (Regulation of Stormwater Discharge).

2. Water Quantity

   At a minimum, all non-exempt stormwater management facilities shall be designed and constructed so as to attenuate stormwater runoff caused by the 25-year, critical duration storm event, or in conformance with the provisions of Chapter 14-86, Florida Administrative Code (Drainage Connection). The maximum hydraulic grade line elevations contained in the Stormwater Management Plan shall be used as a basis for design.

3. To the maximum extent practicable, natural systems shall be used to accommodate stormwater.

4. The proposed stormwater management system shall be designed to accommodate the stormwater that originates within the development and stormwater that flows onto or across the development from adjacent lands. The stormwater system shall not be required to attenuate or treat off-site flows, but must convey off-site flows downstream. In no case shall off-site flows be impeded.

5. The proposed stormwater management system shall be designed to function properly for a minimum twenty (20) year life.

6. No surface water may be channelled or directed into a sanitary sewer.

7. The proposed stormwater management system shall be compatible with the drainage systems or drainage ways on surrounding properties or streets, taking into account the possibility that substandard systems may be improved in the future.

8. The banks of detention and retention areas should be sloped to accommodate, and should be planted with, appropriate vegetation. Vegetated slopes shall not exceed 3:1 for normally dry facilities and 4:1 for wet facilities for a depth of 2 feet below

normal water level.

9. Dredging, clearing of vegetation, deepening, widening, straightening, stabilizing or otherwise altering natural surface waters shall be minimized.

10. Natural surface waters shall not be used as sediment traps during or after development.

11. For aesthetic reasons and to increase shoreline habitat, the shorelines of retention areas shall be sinuous rather than straight.

12. Water reuse and conservation shall, to the maximum extent practicable, be achieved by incorporating the stormwater management system into irrigation systems serving the development.

13. Vegetated buffers of sufficient width to prevent erosion shall be retained or created along the shores, banks or edges of all natural or man-made surface waters.

14. In phased developments the stormwater management system for each integrated stage of completion shall be capable of functioning independently as required by this Code.

15. All detention and retention basins, except natural water bodies used for this purpose, shall be accessible for maintenance from streets or public right-of-way. For facilities where the City of Mexico Beach is to accept maintenance, and area of no less than 10 shall be provided from the top of bank for access by equipment.

16. Necessary erosion and sediment control measures shall be implemented to prevent sediment transport off-site.

xx.032 Certification

1. Design and construction of stormwater management facilities shall be certified by a professional engineer licensed in the State of Florida, and;

2. Where applicable valid permits must be obtained pursuant to Chapter 17-25, FAC and Chapter 14-86, FAC prior to commencement of construction.